United States
Department of
Agriculture

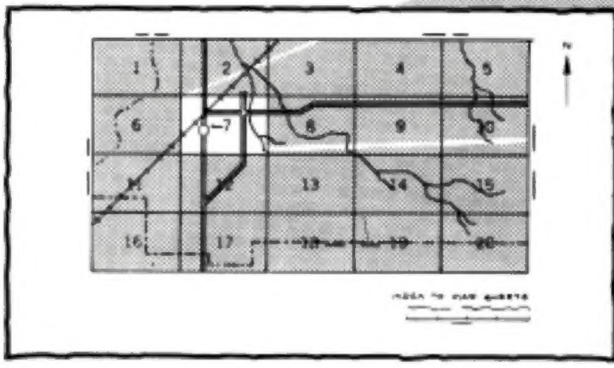
Soil
Conservation
Service

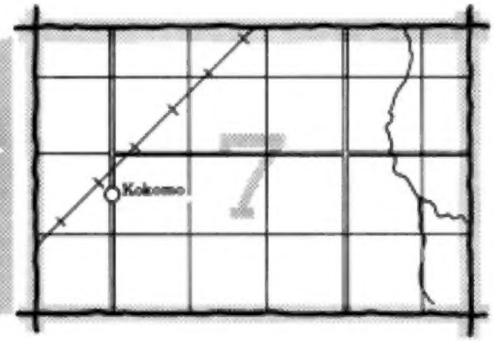
In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Clay County, Kansas

HOW TO USE

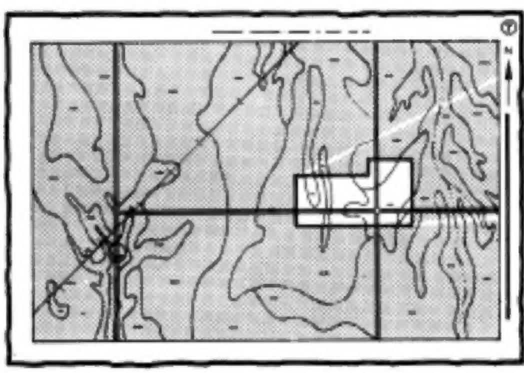
1. Locate your area of interest on the "Index to Map Sheets"

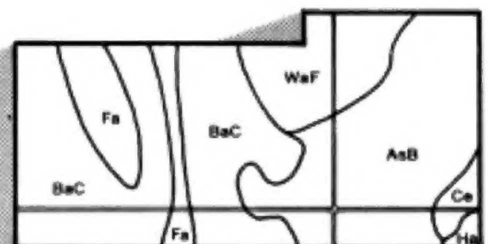




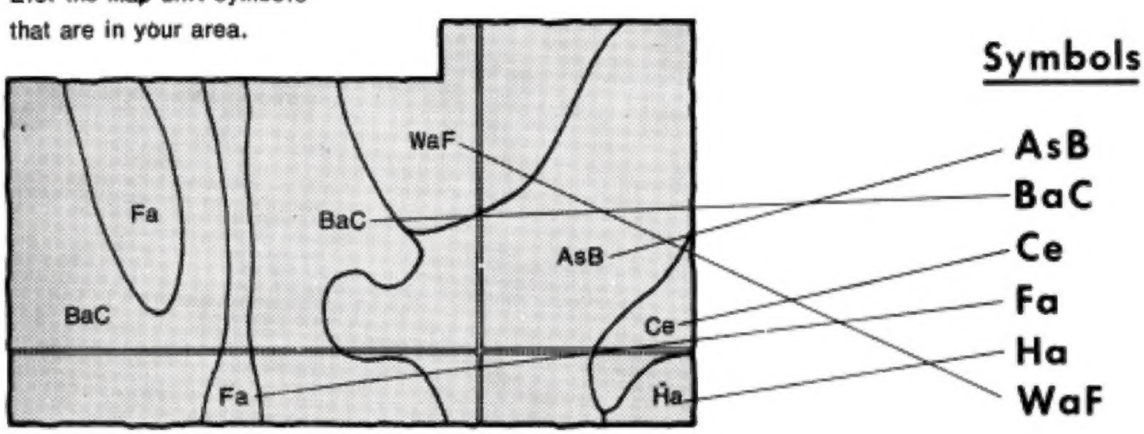
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



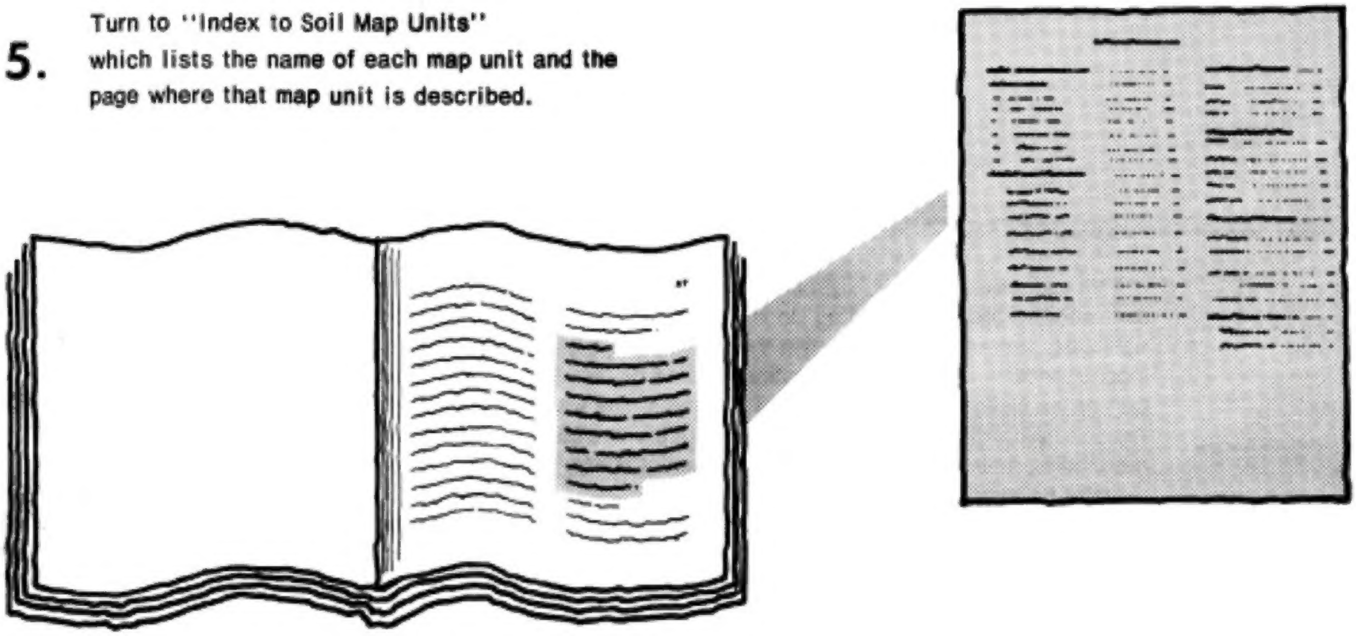


4. List the map unit symbols that are in your area.

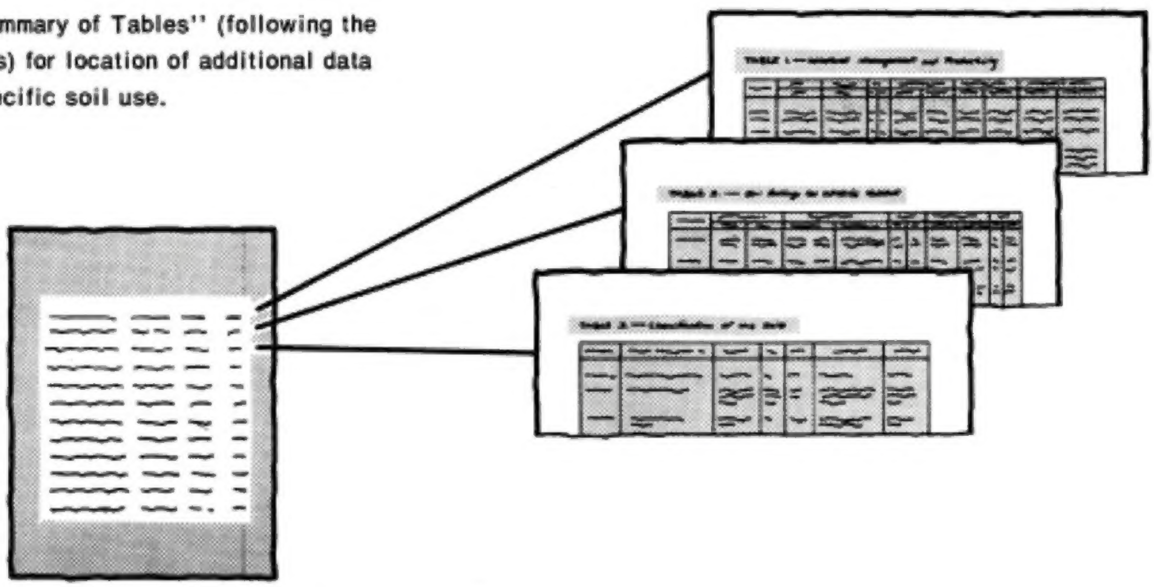


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Clay County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Contour farming in an area of Tully silty clay loam, 2 to 7 percent slopes. Terraces and contour farming help to control erosion on this soil.

Contents

Soil Series

Issued September 1984

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Clay County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie
State Conservationist
Soil Conservation Service

Soil Survey of
Clay County, Kansas

By William A. Wehmueller and Donald E. Rott,
Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
Kansas Agricultural Experiment Station

General Nature of the County

CLAY COUNTY is in north-central Kansas (fig. 1). It has a total area of 419,610 acres, or 656 square miles. In 1982, it had a population of 9,371. Clay Center, the county seat and the largest town, has a population of 4,697.

The western part of the county is in the Central Kansas Sandstone Hills land resource area, and the rest is in the Central Loess Plains land resource area. The soils in the Central Kansas Sandstone Hills are dissected by entrenched drainageways. They are shallow to deep, are gently sloping to moderately steep, and have a clayey or loamy subsoil. The soils on the Central Loess Plains are generally deep, are nearly level to moderately sloping, and have a clayey or silty subsoil. Elevation in the county ranges from 1,100 to 1,500 feet above sea level.

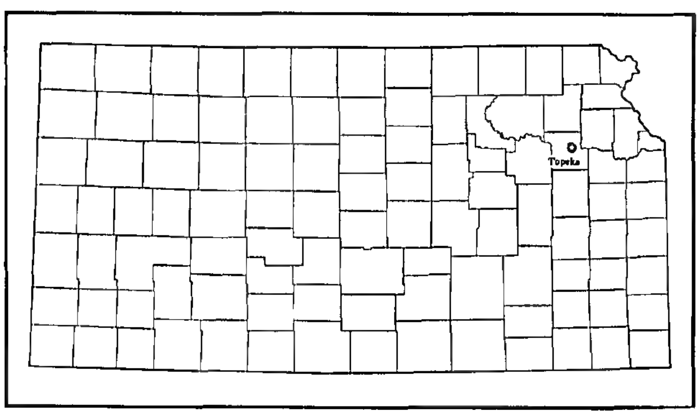


Figure 1.—Location of Clay County in Kansas.

Most of the county is drained by the Republican River. The southwestern part, however, is drained by Chapman Creek and the northeast corner by Fancy Creek (fig. 2).

Farming is the most important enterprise in the county. Wheat and grain sorghum are the main crops. Cattle and hogs are the main kinds of livestock.

This survey updates the soil survey of Clay County, Kansas, published in 1926 (*4*). It provides additional information and larger maps, which show the soils in greater detail.

Climate

Prepared by Merle J. Brown, climatologist, Agricultural Experiment Station, Manhattan, Kansas.

The climate of Clay County is typical continental, as can be expected of a location in the interior of a large landmass in the middle latitudes. This climate is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of polar air. They prevail from December through February. Warm summer temperatures last for

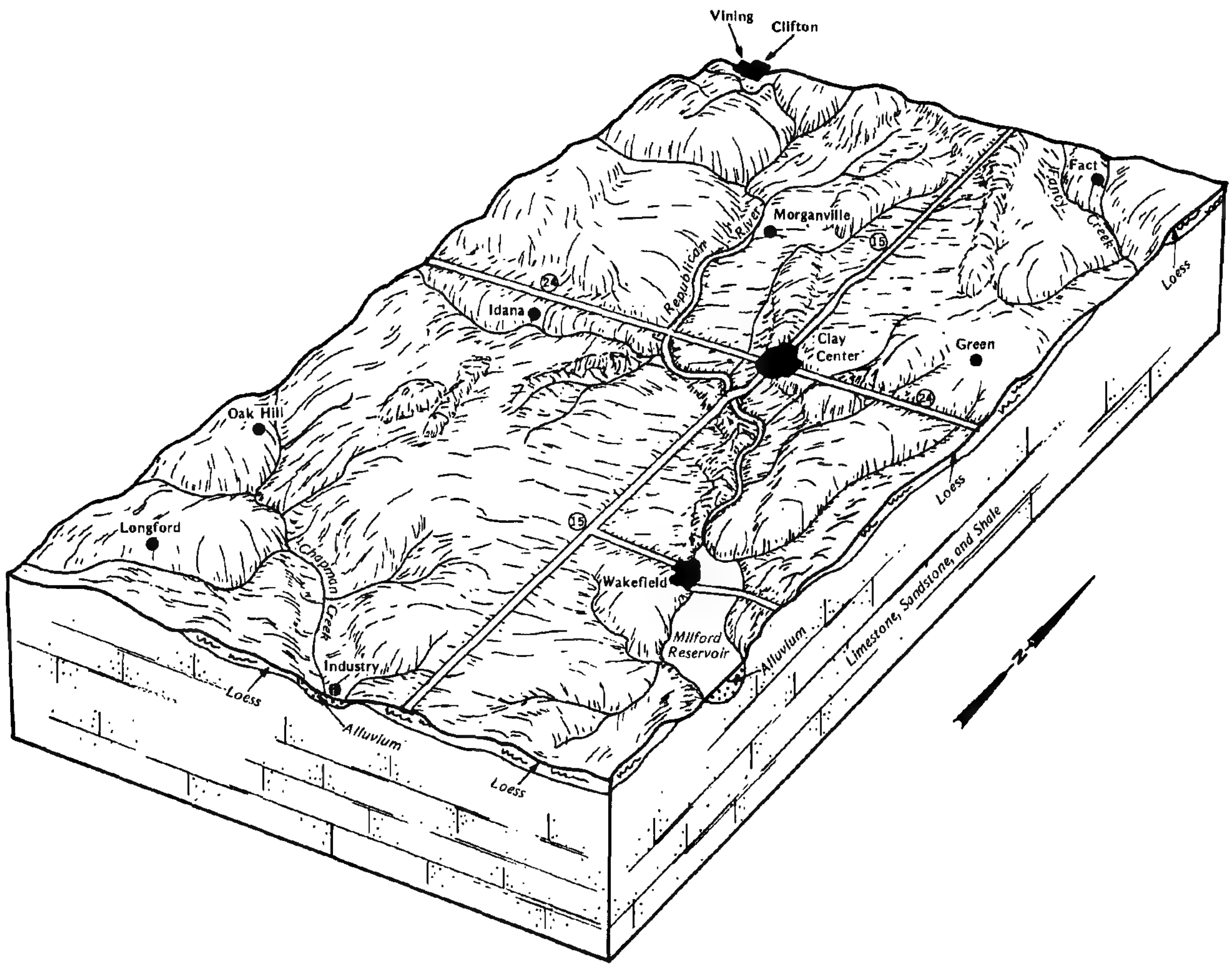


Figure 2.—Drainage, relief, and geologic material in Clay County.

about 6 months every year. Spring and fall are relatively short.

Clay County is generally along the western edge of a current of moisture-laden air from the Gulf of Mexico. Shifts in this current produce a rather large range in the amount of precipitation. Precipitation is heaviest from May through September. Much of it falls during late-evening or nighttime thunderstorms. Precipitation in dry years is marginal for agricultural production. Even in wet years, prolonged periods without rain often result in stress in growing crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Clay Center in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 31.6 degrees F, and the average daily minimum temperature is 20.4 degrees. The lowest temperature on record, which occurred at Clay Center on February 13, 1905, is -35 degrees. In summer the average temperature is 77.7 degrees, and the average daily maximum temperature is 89.9 degrees. The highest recorded temperature, which occurred at Clay Center on August 13, 1936, is 117 degrees.

The total annual precipitation is 31.91 inches. Of this, 23.81 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18.41 inches. The heaviest 1-day rainfall during the period of record was 6.60 inches at Clifton on September 5, 1958.

Tornadoes and severe thunderstorms strike occasionally. These storms are usually local in extent and of short duration, so that the risk of damage is small. Hail falls during the warmer part of the year, but the hailstorms are infrequent and of local extent. They cause less crop damage than the hailstorms farther west.

The average seasonal snowfall is 22.5 inches. The greatest snow depth at any one time during the period of record was 65 inches, which occurred during the winter of 1959-60. On the average, 23 days of the year have at least 1 inch of snow on the ground, but the snow cover seldom lasts more than 7 days in succession.

The sun shines 76 percent of the time possible in summer and 64 percent in winter. The prevailing wind is from the south. Windspeed averages 12.2 miles per hour. It is highest in April.

Natural Resources

Soil is the most important natural resource in the county. Most of the soils are fertile and well suited to agricultural uses. Water of suitable quantity and quality for irrigation is available in most areas adjacent to the Republican River. The Dakota Formation, in the western and northern parts of the county, has many springs and yields moderate amounts of good quality water. The part of the county underlain by rocks of Permian age yields only small quantities of mineralized water to wells. Parts of the county are served by rural water districts.

Sand and gravel are available from pits along the Republican River. Limestone for road surfacing material is quarried in the southeastern part of the county.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management

were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Soil Descriptions

1. Crete-Hobbs Association

Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a clayey or silty subsoil; on uplands and flood plains

This association is on broad ridgetops and side slopes that are drained by intermittent streams. Slope ranges from 0 to 8 percent.

This association makes up about 54 percent of the county. It is about 80 percent Crete soils, 6 percent Hobbs soils, and 14 percent minor soils (fig. 3).

The moderately well drained Crete soils formed in loess. They are nearly level to moderately sloping. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 5 inches thick. The subsoil is silty clay about 24 inches thick. The upper part is dark grayish brown and very firm. The lower part is brown and very firm or firm. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam.

The well drained Hobbs soils formed in alluvium. They are nearly level. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The substratum to a depth of about 60 inches is silt loam. The upper part is stratified dark grayish brown and light brownish gray. The lower part is dark grayish brown.

Minor in this association are Benfield, Geary, Kipson, and Lancaster soils. The moderately deep Benfield and Lancaster soils are on side slopes. Geary soils are less clayey than the Crete soils. They are on side slopes. The shallow Kipson soils are on the steeper side slopes.

About 85 percent of this association is used for cultivated crops. The rest is mainly range. Wheat, grain sorghum, and alfalfa are the main crops. Controlling erosion and maintaining good tilth and fertility are concerns in managing cropland.

2. Crete-Lancaster-Hedville Association

Deep to shallow, moderately sloping to steep, moderately well drained to somewhat excessively drained soils that have a clayey or loamy subsoil; on uplands

This association is in the Dakota Sandstone Hills. It is on ridgetops and side slopes that are dissected by deeply entrenched, intermittent drainageways and small creeks. Sandstone outcrops are common in the steeper areas. Slope ranges from 3 to 30 percent.

This association makes up about 15 percent of the county. It is about 30 percent Crete soils, 30 percent Lancaster soils, 10 percent Hedville soils, and 30 percent minor soils (fig. 4).

The deep, moderately well drained Crete soils formed in loess. They are moderately sloping. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 5 inches thick. The subsoil is silty clay about 24 inches thick. The upper part is dark grayish brown and very firm, and the lower part is brown and very firm or firm. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam.

The moderately deep, well drained Lancaster soils formed in material weathered from noncalcareous sandstone and sandy shale. They are moderately sloping and strongly sloping. Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 26 inches thick. The upper part is brown, firm clay

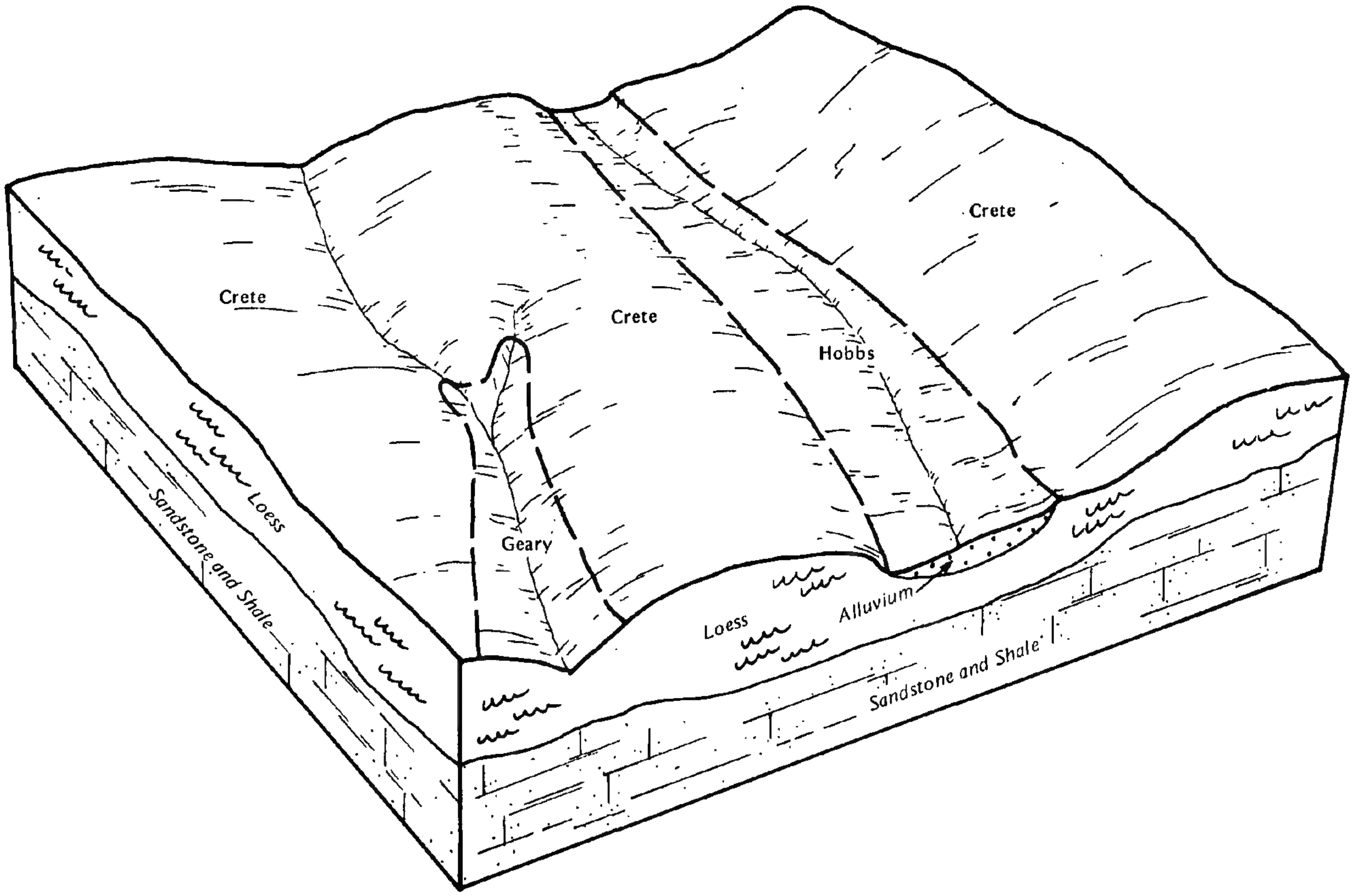


Figure 3.—Typical pattern of soils and underlying material in the Crete-Hobbs association.

loam. The lower part is brown, friable or firm sandy clay loam. Strong brown sandy shale and sandstone bedrock is at a depth of about 35 inches.

The shallow, somewhat excessively drained Hedville soils formed in material weathered from noncalcareous sandstone. They are moderately sloping to steep. Typically, the surface soil is dark grayish brown cobbly loam about 14 inches thick. Sandstone bedrock is at a depth of about 14 inches.

Minor in this association are Edalgo, Geary, Hobbs, and Wells soils. Edalgo soils have a clayey subsoil. They are on side slopes. The deep Geary and Wells soils are on foot slopes or the lower side slopes. The deep Hobbs soils are on narrow flood plains.

This association is used mainly as range, but some small areas on foot slopes are used for hay or cultivated crops. Maintaining a vigorous stand of desirable grasses is the main concern in managing the range.

3. Muir-Eudora Association

Deep, nearly level to moderately sloping, well drained soils that have a silty or loamy subsoil; on terraces and flood plains

This association is on bottom land along the Republican River and other major streams. These soils are subject to flooding. Slope ranges from 0 to 5 percent.

This association makes up about 15 percent of the county. It is about 50 percent Muir soils, 20 percent Eudora soils, and 30 percent minor soils.

The Muir soils formed in silty alluvium. They are nearly level. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 15 inches thick. The subsoil is about 28 inches thick. The upper part is grayish brown, firm silty clay loam. The lower part is grayish brown, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray silt loam.

The Eudora soils formed in silty and loamy alluvium. They are nearly level to moderately sloping. Typically, the surface layer is gray loam about 7 inches thick. The subsurface layer is dark grayish brown, very friable loam about 3 inches thick. The upper part of the substratum is light brownish gray, very friable silt loam. The lower part to a depth of about 60 inches is light gray very fine sandy loam.

Minor in this association are Sarpy and Sutphen soils. The sandy Sarpy soils are on mounds or are near stream channels. The moderately well drained Sutphen soils are in depressions. Other minor soils are Cass, Haynie, and Hobbs soils, which are similar to one or both of the major soils and are in similar landscape positions.

Most of this association is used for cultivated crops. Wheat, grain sorghum, and alfalfa are the main dryland crops. Corn, grain sorghum, and soybeans are the main irrigated crops. Maintaining fertility and good tilth are management concerns.

4. Crete-Kipson-Sogn Association

Deep and shallow, nearly level to moderately steep, moderately well drained and somewhat excessively drained soils that have a clayey or silty subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by deeply entrenched drainageways. Limestone outcrops are common in the steeper areas. Slope ranges from 0 to 20 percent.

This association makes up about 11 percent of the county. It is 53 percent Crete soils, 16 percent Kipson soils, 9 percent Sogn soils, and 22 percent minor soils.

The deep, moderately well drained Crete soils formed in loess. They are nearly level to moderately sloping. Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 5 inches thick. The subsoil is silty clay about 24 inches thick. The upper part is dark grayish brown and very firm. The lower part

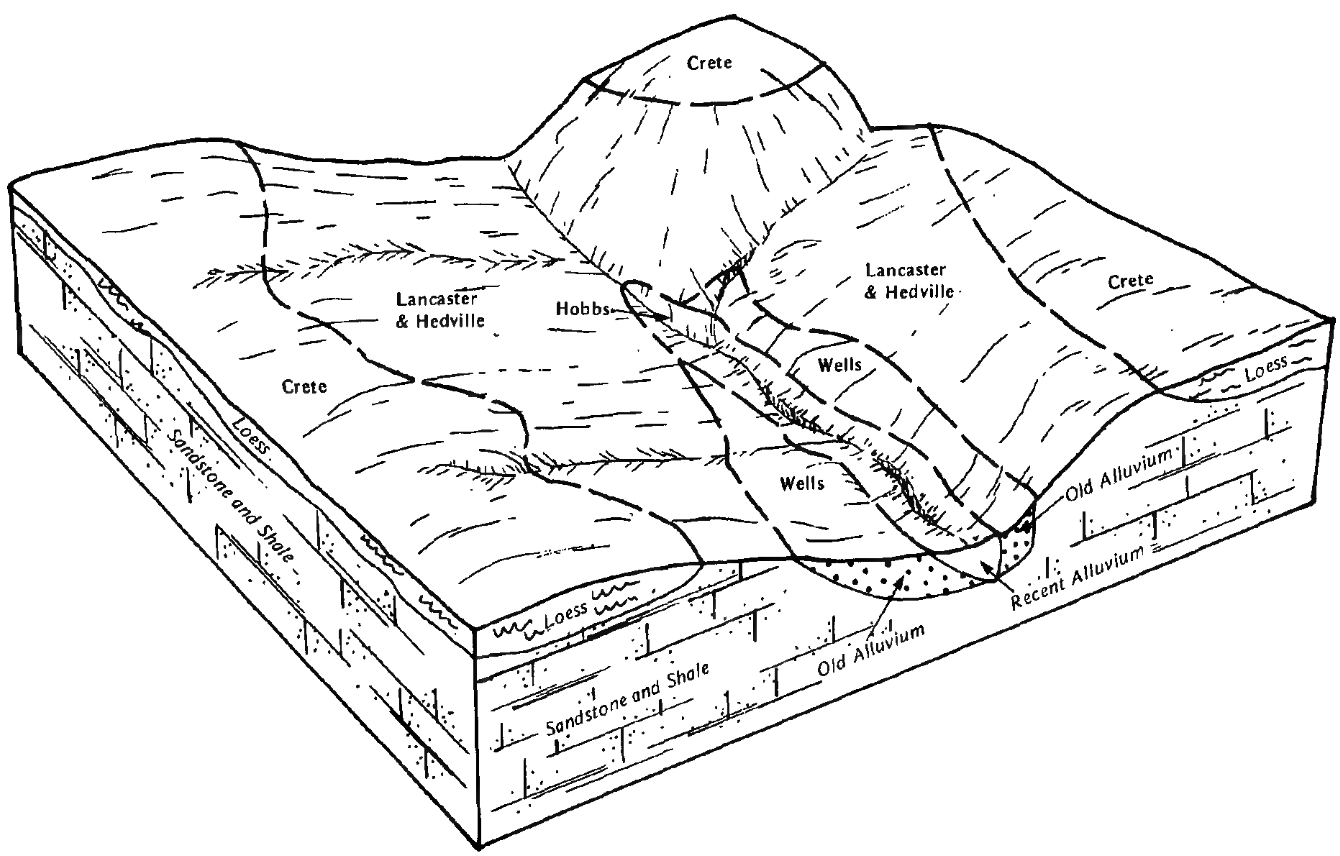


Figure 4.—Typical pattern of soils and underlying material in the Crete-Lancaster-Hedville association.

is brown and very firm or firm. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam.

The shallow, somewhat excessively drained Kipson soils formed in material weathered from calcareous shale. They are moderately sloping to moderately steep. Typically, the surface layer is gray silty clay loam about 8 inches thick. The next layer is light brownish gray, friable silty clay loam about 4 inches thick. The substratum is light gray silty clay loam. Light gray shale bedrock is at a depth of about 18 inches.

The shallow, somewhat excessively drained Sogn soils formed in material weathered from limestone. They are moderately sloping to moderately steep. Typically, the surface soil is dark gray silty clay loam about 12 inches thick. Hard limestone bedrock is at a depth of about 12 inches.

Minor in this association are Benfield, Geary, Hobbs, and Tully soils. The moderately deep Benfield soils are on side slopes. Geary soils are on the lower side slopes adjacent to small streams. They have a silty subsoil. The well drained Hobbs soils are on narrow flood plains. The well drained Tully soils are on foot slopes below the Kipson soils.

About half of this association is used for cultivated crops. The rest is used as range. Wheat and grain sorghum are the main crops. Controlling erosion and maintaining good tilth and fertility are concerns in managing cropland. Maintaining a good stand of desirable grasses is a concern in managing range.

5. Geary-Holder Association

Deep, moderately sloping and strongly sloping, well drained soils that have a silty subsoil; on uplands

This association is on side slopes along the valley of the Republican River. Slope ranges from 2 to 15 percent.

This association makes up about 5 percent of the county. It is about 78 percent Geary soils, 10 percent Holder soils, and 12 percent minor soils.

The Geary soils formed in loess. They are moderately sloping and strongly sloping. Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil is about 31 inches thick. The upper part is reddish brown, friable silt loam. The next part is reddish brown, firm silty clay loam. The lower part is light brown, friable silty clay loam. The substratum to a depth of about 60 inches is light brown silt loam.

The Holder soils formed in loess. They are moderately sloping. Typically, the surface soil is dark grayish brown silt loam about 12 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, friable silty clay loam. The next part is brown, firm silty clay loam. The lower part is pale brown, friable silty clay loam and silt loam. The substratum to a depth of about 60 inches is pale brown silt loam.

Minor in this association are Crete and Kipson soils. The moderately well drained Crete soils are on the upper side slopes and on ridgetops. The shallow Kipson soils are on the steeper side slopes.

Most of this association is used for cultivated crops. Wheat and grain sorghum are the main crops. Controlling erosion and maintaining good tilth and fertility are concerns in managing cropland.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Crete silt loam, 1 to 3 percent slopes, is one of several phases in the Crete series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Lancaster-Hedville complex, 5 to 30 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

Be—Benfield silty clay loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is very firm silty clay about 22 inches thick. The upper part is dark grayish brown, the next part is grayish brown, and the lower part is yellowish brown. Shale bedrock is at a depth of about 32 inches. In places the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Kipson soils and limestone outcrops and slick spots. The shallow Kipson soils are on the lower side slopes. The limestone outcrops are on the steeper breaks on the side slopes. The slick spots are in landscape positions similar to those of the Benfield soil. Included areas make up about 5 percent of the map unit.

Permeability is slow in the Benfield soil, and runoff is medium. Available water capacity is moderate. The shrink-swell potential is high in the subsoil. The surface layer is firm. Tilth is poor. Root penetration is restricted below a depth of about 32 inches.

Most areas are used for cultivated crops. A few are used as range. This soil is moderately well suited to wheat and grain sorghum. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by contour farming, terraces, grassed waterways, and minimum tillage. The moderate depth to bedrock should

be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range. Some areas that formerly were cultivated have been seeded back to grasses. Range seeding is needed to restore productivity on abandoned cropland. The dominant native vegetation is big bluestem, little bluestem, and indiangrass. Overused areas are dominated by blue grama and buffalograss. Proper stocking rates and timely deferment of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling.

This soil generally is unsuited to septic tank absorption fields because of the slow permeability and the depth to bedrock. It is poorly suited to sewage lagoons because of the depth to bedrock. Fill material should be borrowed or the bedrock ripped when lagoons are constructed. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The land capability classification is IVe, dryland, and the range site is Loamy Upland.

Cb—Calco silty clay loam, frequently flooded. This deep, nearly level, very poorly drained soil is on flood plains at the upper end of Milford Reservoir. Individual areas are irregular in shape and are several hundred acres in size.

Typically, the surface soil is very dark gray silty clay loam about 30 inches thick. The next layer is grayish brown, mottled, friable silt loam about 14 inches thick. The substratum to a depth of about 60 inches is light gray and light brownish gray, mottled silt loam. In some areas the surface layer is very fine sandy loam.

Permeability is moderate. Available water capacity is high. Runoff is slow. The depth to a seasonal high water table ranges from 1 to 3 feet. When the water level at Milford Reservoir is high, the surface is covered with water for long periods.

Nearly all areas are used for wildlife habitat. This soil is generally unsuited to cultivated crops because of the flooding and the wetness. The vegetation is water-tolerant grasses, cattails, rushes, and, in places, willows and cottonwoods. It provides habitat for many wildlife species, including ducks, deer, pheasants, and numerous songbirds. The wildlife population can be increased by planting small scattered patches of millet or grain sorghum.

This soil is generally unsuitable for building site development because of the flooding.

The land capability classification is Vw, dryland, and the range site is Subirrigated.

Cg—Cass fine sandy loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from about 30 to 200 acres in size.

Typically, the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsurface layer is dark grayish brown, friable fine sandy loam about 11 inches thick. The next layer is grayish brown, very friable fine sandy loam about 10 inches thick. The substratum to a depth of about 60 inches is light brownish gray. The upper part is loamy fine sand, and the lower part is fine sand. In some areas the soil is calcareous and has a light brownish gray surface layer.

Permeability is moderately rapid, and runoff is slow. Available water capacity is moderate. Tilth is good. Organic matter content is moderately low.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to dryland and irrigated crops. Wheat, sorghum, and alfalfa are the main dryland crops. The main concerns of management are controlling soil blowing and conserving moisture. Also, the flooding can damage the crops. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and maintain fertility.

Corn and grain sorghum are the main irrigated crops. The major management concerns are the efficient use of water and maintenance of soil fertility. Leaving crop residue on the surface helps to maintain tilth and fertility. Controlling the rate of water application helps to conserve irrigation water.

This soil generally is not suited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, dryland and irrigated, and the range site is Sandy Lowland.

Cr—Crete silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from about 15 to 160 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is silty clay about 24 inches thick. The upper part is dark grayish brown and very firm, and the lower part is brown and very firm or firm. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam. In some areas the upper part of the subsoil is mottled.

Permeability and runoff are slow. Available water capacity is high. The shrink-swell potential is high in the subsoil (fig. 5). Tilth is good.

Figure 5.—Cracks caused by shrinking of Crete silt loam, 0 to 1 percent slopes.

Nearly all of the acreage is cultivated. This soil is well suited to wheat, sorghum, and alfalfa. Spring tillage is sometimes delayed because of wetness. Returning crop residue to the soil increases the rate of water infiltration, conserves moisture, improves fertility, and helps to maintain good tilth.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed by the soil if the lateral lines are installed below the clayey subsoil. Increasing the size of the absorption field also helps to overcome the slow permeability.

This soil is moderately well suited to sewage lagoons. Seepage is a limitation. It can be controlled by sealing the lagoon. In places the clayey subsoil can be used to seal the lagoon.

The land capability classification is IIs, dryland, and the range site is Clay Upland.

Cs—Crete silt loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on the upper side slopes and the tops of ridges in the uplands. Individual areas are irregular in shape and range from 15 to more than 1,000 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is silty clay about 24 inches thick. The upper part is dark grayish brown and very firm, and the lower part is brown and very firm or firm. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam. In eroded areas the surface layer is grayish brown silty clay loam. In some areas the substratum is brown clay loam.

Included with this soil in mapping are small areas of Benfield and Hobbs soils. The moderately deep Benfield soils are on the lower parts of side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded. Included soils make up about 5 percent of the map unit.

Runoff is medium on the Crete soil, and permeability is slow. Available water capacity is high. The shrink-swell potential is high in the subsoil. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to wheat, sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil increases the rate of water infiltration, improves fertility, and helps to prevent surface crusting.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed by the soil if the lateral lines are installed below the clayey subsoil. Increasing the size of the absorption field also helps to overcome the slow permeability.

This soil is moderately well suited to sewage lagoons. Seepage and slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, dryland, and the range site is Clay Upland.

Ct—Crete silty clay loam, 3 to 7 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex side slopes in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 24 inches thick. The upper part is very dark grayish brown, firm silty clay loam. The next part is brown, very firm silty clay. The lower part is grayish brown, firm silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silty clay loam. In some areas it is brown clay loam.

Included with this soil in mapping are small areas of Benfield, Geary, Hobbs, and Lancaster soils. The moderately deep Benfield and Lancaster soils are on the upper parts of side slopes. Geary soils have a silty subsoil and are on the lower side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded. Included soils make up about 10 percent of the map unit.

Permeability is slow in the Crete soil, and runoff is medium. Available water capacity is high. Tilth is fair. The shrink-swell potential is high in the subsoil.

Most of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, sorghum, and alfalfa. If used for cultivated crops, it is subject to erosion. Terracing, establishing grassed waterways, farming on the contour, returning crop residue to the soil, and minimizing tillage help to control erosion and maintain the organic matter content and tilth (fig. 6).

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed by the soil if the lateral lines are installed below the clayey subsoil. Increasing the size of the absorption field also helps to overcome the slow permeability.

This soil is moderately well suited to sewage lagoons. Seepage and slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. Some land shaping is commonly needed.

The land capability classification is IIIe, dryland, and the range site is Clay Upland.

Cx—Crete silty clay loam, 3 to 8 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on side slopes in the uplands. Rills are common, and gullies form in places. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. It is a mixture of the original surface layer and the subsoil. The subsoil is about 22 inches thick. The upper part is brown, very firm silty clay. The lower part is grayish brown, firm silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silty clay loam. In some

Figure 6.—A grassed waterway in an area of Crete silty clay loam, 3 to 7 percent slopes. The waterway helps to control erosion and provides a hay crop.

areas the surface layer is silty clay. In others the substratum is brown clay loam.

Included with this soil in mapping are small areas of Benfield, Geary, and Kipson soils. The moderately deep Benfield soils are on the upper side slopes. Geary soils have a silty subsoil and are on the lower side slopes. The shallow Kipson soils are on the steeper side slopes. Included soils make up about 10 percent of the map unit.

Permeability is slow in the Crete soil, and runoff is medium. Available water capacity is high. Organic matter content is moderately low. The shrink-swell potential is high in the subsoil. The surface layer is firm, and tilth is poor. The surface crusts when dry and puddles when wet.

Most areas are used for cultivated crops. Some are used as range. This soil is moderately well suited to wheat and grain sorghum. If cultivated crops are grown, further erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. A cover of grasses is effective in controlling erosion. Range seeding is needed to restore productivity on abandoned cropland. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed by the soil if the lateral lines are installed below the clayey subsoil. Increasing the size of the absorption field also helps to overcome the slow permeability.

This soil is moderately well suited to sewage lagoons. Seepage and slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. Some land shaping is commonly needed.

The land capability classification is IVe, dryland, and the range site is Clay Upland.

Ed—Edalgo silty clay loam, 4 to 8 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 90 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is brown, very firm silty clay about 18 inches thick. The substratum also is brown silty clay. Light gray and yellow shale bedrock is at a depth of about 34 inches. In places the depth to shale is more than 40 inches.

Included with this soil in mapping are small areas of Crete, Hedville, and Lancaster soils. The deep Crete soils are on the upper side slopes. The shallow Hedville soils are on the steeper slopes and breaks. Lancaster soils have a loamy subsoil and are on the upper side slopes. Included soils make up about 5 percent of the map unit.

Permeability is very slow in the Edalgo soil, and runoff is rapid. Available water capacity is low. The shrink-swell potential is high in the subsoil. The surface layer is firm, and tilth is poor. Root penetration is restricted below a depth of about 34 inches.

Most areas are used as range. A few are cultivated. This soil is poorly suited to cultivated crops. Wheat and sorghum are the main crops. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, maintain the organic matter content, and improve tilth.

This soil is best suited to range. In the areas used as range, the native vegetation is dominantly big bluestem, little bluestem, and indiangrass. Overgrazing reduces the extent of the plant cover and causes deterioration of the plant community. Under these conditions, the taller grasses are replaced by less productive grasses and weeds, such as tall dropseed and western ragweed. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. In some areas invasion of brushy plants, such as sumac and eastern redcedar, is a concern of management. Timely burning helps to control the trees and brush. Range seeding is needed to restore productivity on abandoned cropland.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling.

This soil is generally unsuitable as a site for septic tank absorption fields because of the very slow permeability and the depth to bedrock. It is poorly suited to sewage lagoons because of the depth to bedrock. Fill material should be borrowed or the bedrock ripped when lagoons are constructed. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock.

The land capability classification is IVe, dryland, and the range site is Clay Upland.

Er—Eudora very fine sandy loam, 2 to 5 percent slopes. This deep, moderately sloping, well drained soil is on terrace escarpments that are subject to rare flooding. Individual areas are about 120 to 400 feet wide and about 0.25 to 1.0 mile long. They range from 5 to more than 60 acres in size.

Typically, the surface layer is gray very fine sandy loam about 7 inches thick. The substratum to a depth of

about 60 inches is light brownish gray. The upper part is silt loam, and the lower part is calcareous very fine sandy loam. In some areas the surface layer is light brownish gray.

Included with this soil in mapping are small areas of the sandy Sarpy soils. These soils are on small mounds. They make up about 5 percent of the map unit.

Permeability is moderate in the Eudora soil, and available water capacity is high. Runoff is medium. Tilth is good. Organic matter content is moderately low.

Most areas are used as cropland. This soil is well suited to wheat, sorghum, and alfalfa. Erosion is a hazard if the soil is cultivated and not protected. Terracing is impractical in most places because of short slopes. Minimum tillage and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility and tilth and helps to prevent surface crusting.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIe, dryland and irrigated, and the range site is Loamy Terrace.

Eu—Eudora loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface soil is loam about 10 inches thick. It is gray in the upper part and dark grayish brown in the lower part. The upper part of the substratum is light brownish gray, very friable silt loam. The lower part to a depth of about 60 inches is light gray very fine sandy loam. In some areas the surface layer is silt loam or very fine sandy loam.

Included with this soil in mapping are a few small areas of the sandy Sarpy soils. These soils are on small mounds. They make up about 5 percent of the map unit.

Permeability is moderate in the Eudora soil, and available water capacity is high. Runoff is slow. Tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to dryland and irrigated crops. Wheat, sorghum, soybeans, and alfalfa are the main dryland crops. The main concerns of management are controlling soil blowing and conserving moisture. Also, the flooding can damage the crops. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and maintain fertility.

Corn, grain sorghum, and alfalfa are the main irrigated crops. The main management concerns are the efficient use of water and maintenance of soil fertility. Leaving crop residue on the surface helps to maintain tilth and fertility. Controlling the rate of water application helps to conserve irrigation water.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, dryland and irrigated, and the range site is Loamy Lowland.

Gc—Geary silt loam, 2 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes along creek and river valleys. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil is about 31 inches thick. The upper part is reddish brown, friable silt loam. The next part is reddish brown, firm silty clay loam. The lower part is light brown, friable silty clay loam. The substratum to a depth of about 60 inches is light brown silt loam.

Included with this soil in mapping are small areas of Crete and Hobbs soils. Crete soils have a subsoil that is more clayey than that of the Geary soil. They are on the upper side slopes. Hobbs soils are along narrow drainageways and are occasionally flooded. Included soils make up about 5 percent of the map unit.

Permeability is moderate in the Geary soil, and runoff is medium. Available water capacity is high. Tilth is good. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivation crops. The rest are used as range. This soil is moderately well suited to wheat, sorghum, and soybeans. If used for cultivated crops, it is subject to erosion. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The native vegetation is mostly mid and tall grasses, such as little bluestem and big bluestem. Overgrazing reduces the vigor and growth of the grasses. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil is well suited to dwellings; however, the shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material help to prevent the damage to buildings caused by shrinking and swelling.

This soil is moderately well suited to septic tank absorption fields and sewage lagoons. The absorption of effluent in septic tank systems is somewhat restricted by the moderate permeability. Enlarging the absorption field commonly overcomes this limitation. Seepage and slope are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping is commonly needed to compensate for the slope.

The land capability classification is IIIe, dryland, and the range site is Loamy Upland.

Gf—Geary silt loam, 9 to 15 percent slopes. This deep, strongly sloping, well drained soil is on side slopes along creek and river valleys. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface soil is dark grayish brown silt loam about 12 inches thick. The subsoil is silty clay loam about 30 inches thick. The upper part is dark brown and friable. The lower part is brown and firm. The substratum to a depth of about 60 inches is brown silt loam.

Included with this soil in mapping are small areas of the shallow Kipson soils and rock outcrops. These included areas are on the steeper slopes and breaks. They make up about 10 percent of the map unit.

Permeability is moderate in the Geary soil, and runoff is rapid. The shrink-swell potential is moderate in the subsoil. Available water capacity is high.

Most areas are used as range. Because erosion is a severe hazard, this soil is generally unsuited to cultivated crops. It is suited to range. The dominant native vegetation is big bluestem, little bluestem, and indiangrass. Overused areas are dominated by blue grama, buffalograss, and sideoats grama. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

In a few areas part of the vegetation is oak, ash, and hackberry. This vegetation provides habitat for many types of wildlife species, including quail, deer, rabbits, squirrels, and numerous songbirds. Proper grazing use and establishment of feed areas increase the wildlife population.

This soil is moderately well suited to dwellings. The shrink-swell potential and the strong slopes are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling. Less land shaping is required if dwellings are constructed on the less sloping parts of the landscape.

This soil is moderately well suited to septic tank absorption fields and is poorly suited to sewage lagoons. The slope is a limitation affecting both uses. Also, the moderate permeability somewhat restricts the absorption of effluent in septic tank absorption fields. Lateral lines in these fields should be installed on the contour. Increasing the size of the absorption field helps to overcome the moderate permeability. If less sloping areas are selected as sites for lagoons, less leveling and banking will be required during construction.

The land capability classification is VIe, dryland, and the range site is Loamy Upland.

Gh—Geary silty clay loam, 4 to 9 percent slopes, eroded. This deep, moderately sloping, well drained soil is on side slopes along creek and river valleys. In some areas rills and gullies are common. Individual areas are irregular in shape and range from 80 to several hundred acres in size.

Typically, the surface layer is brown silty clay loam about 7 inches thick. It is a mixture of the original surface layer and the subsoil. The subsoil is firm silty clay loam about 25 inches thick. The upper part is brown, and the lower part is reddish brown. The substratum to a depth of about 60 inches is reddish brown silt loam. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of Crete and Hobbs soils. Crete soils contain more clay in the subsoil than the Geary soil. They are on the upper side slopes and the tops of ridges. Hobbs soils are along narrow drainageways and are occasionally flooded. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Geary soil, and runoff is rapid. Available water capacity is high. The shrink-swell potential is moderate. Organic matter content is moderately low. Tilth is poor. The surface layer crusts when dry and puddles when wet.

Most of the acreage is used for cultivated crops. The rest is used as range. This soil is poorly suited to cultivated crops. Wheat and sorghum are the main crops. If cultivated crops are grown, further erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, maintain the organic matter content, and improve tilth.

This soil is suited to range. A cover of range plants is effective in controlling erosion. Range seeding is needed to restore productivity on abandoned cropland. Overgrazing, however, retards the growth and reduces the vigor of grasses. Proper stocking rates, deferred grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material help to prevent the damage to buildings caused by shrinking and swelling.

The soil is moderately well suited to septic tank absorption fields and sewage lagoons. The absorption of effluent in septic tank absorption fields is somewhat restricted by the moderate permeability. Enlarging the absorption field commonly overcomes this limitation. Slope and seepage are limitations on sites for sewage lagoons. Sealing the lagoon helps to control seepage. Some land shaping is commonly needed to compensate for the slope.

The land capability classification is IVe, dryland, and the range site is Loamy Upland.

Gm—Gibbon loam, occasionally flooded. This deep, nearly level, somewhat poorly drained soil is on flood plains. Individual areas are irregular in shape and range from 80 to several hundred acres in size.

Typically, the surface soil is dark grayish brown, calcareous loam about 14 inches thick. The subsoil is about 22 inches of light brownish gray, mottled, friable, calcareous loam and very fine sandy loam. The substratum to a depth of about 60 inches is calcareous. The upper part is light gray, mottled very fine sandy loam. The lower part is light brownish gray fine sand.

Included with this soil in mapping are small areas of the well drained Eudora soils. These soils are slightly higher on the landscape than the Gibbon soil. They make up about 5 percent of the map unit.

Permeability is moderate in the Gibbon soil, and available water capacity is high. Runoff is slow. Tilth is good. The depth to a seasonal high water table ranges from 1.5 to 3.0 feet.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. The wetness sometimes delays tillage. It can be reduced by open drains or tile drains if adequate outlets are available. Minimizing tillage and leaving crop residue on the surface help to maintain the organic matter content, fertility, and tilth.

This soil is generally unsuited to building site development because of the flooding and the wetness.

The land capability classification is IIw, dryland and irrigated, and the range site is Subirrigated.

He—Haynie-Sarpy complex, occasionally flooded. These deep soils are on flood plains. They are commonly adjacent to river channels and in abandoned channels of the Republican River. The Haynie soil is well drained and nearly level. The Sarpy soil is excessively drained and undulating. Individual areas are long and narrow and range from 20 to 200 acres in size. They are about 60 percent Haynie soil and 30 percent Sarpy soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Haynie soil has a surface layer of dark grayish brown silt loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous. The upper part is stratified grayish brown and dark grayish brown silt loam. The lower part is light brownish gray very fine sandy loam.

Typically, the Sarpy soil has a surface layer of grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is very pale brown. The upper part is loamy fine sand, the next part is fine sand, and the lower part is loamy fine sand.

Included with these soils in mapping are small areas of the clayey Sutphen soils. These included soils are in the old oxbows. They make up about 10 percent of the map unit.

Permeability is moderate in the Haynie soil, available water capacity is high, and organic matter content is moderately low. Permeability is rapid in the Sarpy soil, and available water capacity and organic matter content are low. Runoff is slow on both soils.

Nearly all the acreage is used as wildlife habitat. These soils are generally unsuited to cultivated crops because of the flooding on both soils and the low available water capacity in the Sarpy soil. Also, operating machinery is difficult along the stream channels. The vegetation is oak, ash, cottonwood, and hackberry and an understory of mid and tall grasses. This vegetation and the cultivated crops in nearby areas of arable soils provide habitat for many wildlife species, including quail, deer, rabbits, squirrels, and numerous songbirds. The abandoned river channels provide habitat for many wetland wildlife species, including ducks and geese. Establishing feed areas increases the wildlife population.

These soils are generally unsuitable for building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is VIw, dryland. The Haynie soil is in the Loamy Lowland range site, and the Sarpy soil is in the Sandy Lowland range site.

Hn—Hobbs silt loam, channeled. This deep, nearly level, well drained soil is on flood plains that are dissected by deeply entrenched drainageways. It is frequently flooded. Individual areas are long and narrow and range from 20 to 300 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The substratum to a depth of about 60 inches is silt loam. The upper part is stratified dark grayish brown and light brownish gray. The lower part is dark grayish brown.

Included with this soil in mapping are small areas of Crete, Geary, and Muir soils. Crete and Geary soils have a subsoil of silty clay or silty clay loam. They are on side slopes in the adjacent uplands. Muir soils are on the higher stream terraces and are subject to rare flooding. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Hobbs soil, and runoff is slow. Available water capacity is high. Scouring and deposition occur along and near the stream channels.

Most areas are used as range or wildlife habitat. This soil is generally unsuited to cultivated crops because of the flooding. Also, operating machinery is difficult along the meandering stream channels.

This soil is suited to range. Many areas of range are overgrazed and in poor condition because they are near watering facilities and shade trees where livestock congregate. In these areas the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing improve the range condition.

The vegetation commonly growing on this soil provides habitat for many types of wildlife species, including quail, deer, rabbits, and numerous songbirds. The wildlife population can be increased by establishing more fringe areas where woodland is adjacent to cropland.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw, dryland, and the range site is Loamy Lowland.

Ho—Hobbs silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains along upland drainageways. Individual areas range from 200 to 1,000 feet in width and from 500 feet to more than a mile in length. They range from 5 to more than 160 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The substratum to a depth of about 60 inches is silt loam. The upper part is stratified dark grayish brown and light brownish gray. The lower part is dark grayish brown.

Included with this soil in mapping are small areas of Sutphen soils in depressions. These soils are more clayey than the Hobbs soil. They make up about 5 percent of the map unit.

Permeability is moderate in the Hobbs soil, and runoff is slow. Available water capacity is high. Tilth is good.

About half of the acreage is used for cultivated crops, and half is used for range or wildlife habitat. This soil is well suited to wheat, sorghum, soybeans, and alfalfa. Floodwater damages crops in some years, but in other years the extra moisture increases productivity. Dikes and diversions help to prevent crop damage. Minimizing tillage and leaving crop residue on the surface help to maintain fertility and the organic matter content and conserve moisture.

This soil is suited to range. Big bluestem, little bluestem, and switchgrass are the main species in areas where the range is in good condition. Many areas of range are overgrazed, however, and are in poor condition. In these areas the more desirable grasses are replaced by less productive grasses and by weeds. Livestock congregate in areas where shade trees and watering facilities are commonly located. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition. Placing salt blocks on the steeper adjacent soils helps to achieve a uniform distribution of grazing.

In wooded areas the dominant species are hackberry, ash, black walnut, and oak. This vegetation provides habitat for many types of wildlife species, including quail, deer, rabbits, squirrels, and numerous songbirds. Good woodland management increases the wildlife population.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, dryland and irrigated, and the range site is Loamy Lowland.

Hr—Holder silt loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes along creek and river valleys. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface soil is dark grayish brown silt loam about 12 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, friable silty clay loam. The next part is brown, firm silty clay loam. The lower part is pale brown, friable silty clay loam and silt loam. The substratum to a depth of about 60 inches is pale brown silt loam. In some areas the subsoil is reddish brown.

Included with this soil in mapping are small areas of the moderately well drained Crete soils. These soils are on the upper parts of side slopes. They make up about 5 percent of the map unit.

Permeability is moderate in the Holder soil, and available water capacity is high. Runoff is medium. Tilth is good. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. The rest are used as range. This soil is moderately well suited to wheat, sorghum, and soybeans. If cultivated crops are grown, erosion is a hazard. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The dominant native vegetation is big bluestem, little bluestem, and switchgrass. Overused areas are dominated by blue grama, buffalograss, and sideoats grama. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage from lagoons is a limitation. It can be controlled by sealing the floor of the lagoon. If less sloping areas are selected as sites for lagoons, less leveling and banking will be required during construction.

The land capability classification is IIIe, dryland, and the range site is Loamy Upland.

Ks—Kipson-Sogn silty clay loams, 5 to 20 percent slopes. These moderately sloping to moderately steep, somewhat excessively drained, shallow soils are on side slopes in the uplands. Individual areas are irregular in

shape and range from 50 to several hundred acres in size. They are about 70 percent Kipson soil and 15 percent Sogn soil. The two soils are in alternate narrow bands that run along the contour of the slope. They occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Kipson soil is calcareous throughout. It has a surface layer of gray silty clay loam about 8 inches thick. The next 4 inches is light brownish gray, friable silty clay loam. The substratum is light gray silty clay loam. Shale bedrock is at a depth of 18 inches (fig. 7). In places the depth to shale is more than 20 inches.

Typically, the Sogn soil has a surface soil of dark gray silty clay loam about 12 inches thick. Hard limestone bedrock is at a depth of about 12 inches.

Included with these soils in mapping are small areas of the deep Crete and Tully soils and limestone outcrops. Crete soils are on the upper side slopes and the tops of ridges. Tully soils are on foot slopes below the Kipson soil. The limestone outcrops are on steep breaks below the Sogn soil. Included areas make up about 15 percent of the map unit.

Runoff is rapid on the Kipson and Sogn soils, and permeability is moderate. Available water capacity is very low. The shrink-swell potential is moderate. Root penetration is restricted by the shale at a depth of about 18 inches in the Kipson soil and by the limestone at a depth of about 12 inches in the Sogn soil.

Nearly all areas are used as range. These soils are generally unsuited to cultivated crops because of a severe hazard of erosion and because rocks at or near the surface interfere with tillage in many areas. The soils are best suited to range. The native vegetation dominantly is little bluestem and big bluestem. Sideoats grama is more common on the Sogn soil than on the Kipson soil. In severely overgrazed areas, the range is invaded by buffalograss, annual broomweed, and other less desirable vegetation. Management that maintains an adequate vegetative cover conserves moisture by reducing the runoff rate. In many areas some form of brush control is needed. Proper stocking rates, a uniform distribution of grazing, timely deferment of grazing, timely burning, and a rotation grazing system help to keep the range in good condition.

The Kipson soil is poorly suited to dwellings because of the depth to bedrock, the shrink-swell potential, and the slope. The rock is soft and can be easily excavated. Less land shaping is required if the dwellings are constructed on the smoother, less sloping parts of the landscape. Properly designing and reinforcing foundations and backfilling with suitable coarse material help to prevent the damage to buildings caused by shrinking and swelling.

The Kipson soil is generally unsuited to septic tank absorption fields because of the depth to bedrock. It is poorly suited to sewage lagoons because of the depth to bedrock and the slope. Fill material should be borrowed

Figure 7.—Profile of Kipson silty clay loam. The arrow indicates the depth to shale. Depth is marked in feet.

or the bedrock ripped if sewage lagoons are constructed. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. If less sloping areas are selected as sites for lagoons, less leveling and banking will be required during construction. The deep included soils on the lower side slopes and on foot slopes are better sites for lagoons.

The Sogn soil is generally unsuited to building site development because of the depth to hard limestone bedrock.

The land capability classification is VIe, dryland. The Kipson soil is in the Limy Upland range site, and the Sogn soil is in the Shallow Limy range site.

Lc—Lancaster loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 90 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 26 inches thick. The upper part is brown, firm clay loam. The lower part is brown, firm or friable sandy clay loam. Strong brown sandy shale and soft sandstone bedrock is at a depth of about 35 inches. In places the depth to bedrock is more than 40 inches.

Included with this soil in mapping are small areas of the shallow Hedville soils. These soils are on ridgetops. They make up about 5 percent of the map unit.

Permeability and available water capacity are moderate in the Lancaster soil. Runoff is medium. Tilth is good. Root development is restricted below a depth of about 35 inches.

About half of the acreage is cultivated, and half is used as range. This soil is moderately well suited to cultivated crops. Wheat, grain sorghum, and forage sorghum are the main crops. Erosion and droughtiness are management concerns if the soil is cultivated. Terracing, establishing grassed waterways, farming on the contour, and returning crop residue to the soil conserve moisture and help to prevent excessive soil loss. The depth to bedrock should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range. The native vegetation is dominantly big bluestem, little bluestem, and indiangrass. In overused areas the range is invaded by less productive grasses and weeds, such as blue grama and ragweed. Distribution of livestock can be improved by properly locating fences, water supplies, and salting facilities.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and footings help to prevent the structural damage caused by shrinking and swelling. The depth to bedrock is a limitation affecting dwellings with basements, but in most places the rock is soft and can be excavated.

This soil is poorly suited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deeper soils on the adjacent foot slopes are better sites for these uses. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IVe, dryland, and the range site is Loamy Upland.

Lh—Lancaster-Hedville complex, 5 to 30 percent slopes. These soils are on side slopes and ridgetops in the uplands. The moderately deep, moderately sloping and strongly sloping, well drained Lancaster soil is on the middle and upper parts of the side slopes. The shallow, moderately sloping to steep, somewhat excessively drained Hedville soil is on narrow, convex ridges and breaks and on the lower side slopes along some drainageways. Individual areas are irregular in shape and range from 5 to several hundred acres in size. They are about 55 percent Lancaster soil and 30 percent Hedville soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Lancaster soil has a surface layer of dark grayish brown loam about 9 inches thick. The subsoil is about 26 inches thick. The upper part is brown, firm clay loam. The lower part is brown, firm or friable sandy clay loam. Strong brown sandy shale and soft sandstone bedrock is at a depth of about 35 inches. In places the depth to bedrock is more than 40 inches.

Typically, the Hedville soil has a surface layer of dark grayish brown cobbly loam about 14 inches thick. Sandstone bedrock is at a depth of about 14 inches.

Included with these soils in mapping are small areas of Crete and Edalgo soils and sandstone outcrops. Also included is a loamy, poorly drained soil on flood plains along drainageways. The deep Crete soils are on the less sloping ridgetops. Edalgo soils have a clayey subsoil. They are in landscape positions similar to those of the Lancaster soil. The sandstone outcrops are on the steeper points, breaks, and side slopes. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Lancaster and Hedville soils, and runoff is rapid. Available water capacity is moderate in the Lancaster soil and very low in the Hedville soil. The shrink-swell potential is moderate in the subsoil of the Lancaster soil.

Nearly all of the acreage is used as range (fig. 8). Because erosion is a severe hazard, these soils are generally unsuited to cultivated crops. They are suited to range. The native vegetation dominantly is big bluestem, little bluestem, and indiangrass. In overgrazed areas these grasses are replaced by less desirable plants, such as blue grama and tall dropseed. Proper stocking

rates help to keep the range in good condition. Some of the steeper areas are infrequently grazed by livestock. Well-distributed watering and salting facilities and properly located fences improve the distribution of grazing (fig. 9). Suitable sites for stock water ponds generally are available.

The Lancaster soil is moderately well suited to dwellings. The shrink-swell potential and the slope are limitations. Also, the depth to bedrock is a limitation on sites for dwellings with basements, but in most areas the rock is soft and can be easily excavated. Properly designing and reinforcing foundations and footings help to prevent the structural damage caused by shrinking and swelling. Less land shaping will be needed if the smoother, less sloping parts of the landscape are selected as sites for the dwellings.

The Lancaster soil is poorly suited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deeper soils on foot slopes are better sites for these uses. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The Hedville soil is generally unsuited to building site development because it is shallow over sandstone.

The land capability classification is VIe, dryland. The Lancaster soil is in the Loamy Upland range site, and the Hedville soil is in the Shallow Sandstone range site.

Mu—Muir silt loam. This deep, nearly level, well drained soil is on stream terraces that are subject to rare flooding. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 15 inches thick. The subsoil is about 28 inches thick. The upper part is dark grayish brown, firm silty clay loam. The lower part is grayish brown, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray silt loam. In some areas the surface layer is loam.

Included with this soil in mapping are small areas of the moderately well drained Sutphen soils. These soils are in depressions. They make up about 5 percent of the map unit.

Runoff is slow on the Muir soil, and permeability is moderate. Available water capacity is high. Tilth is good.

Nearly all of the acreage is cropland. This soil is well suited to wheat, sorghum, soybeans, and alfalfa. The main concern of management is maintenance of fertility

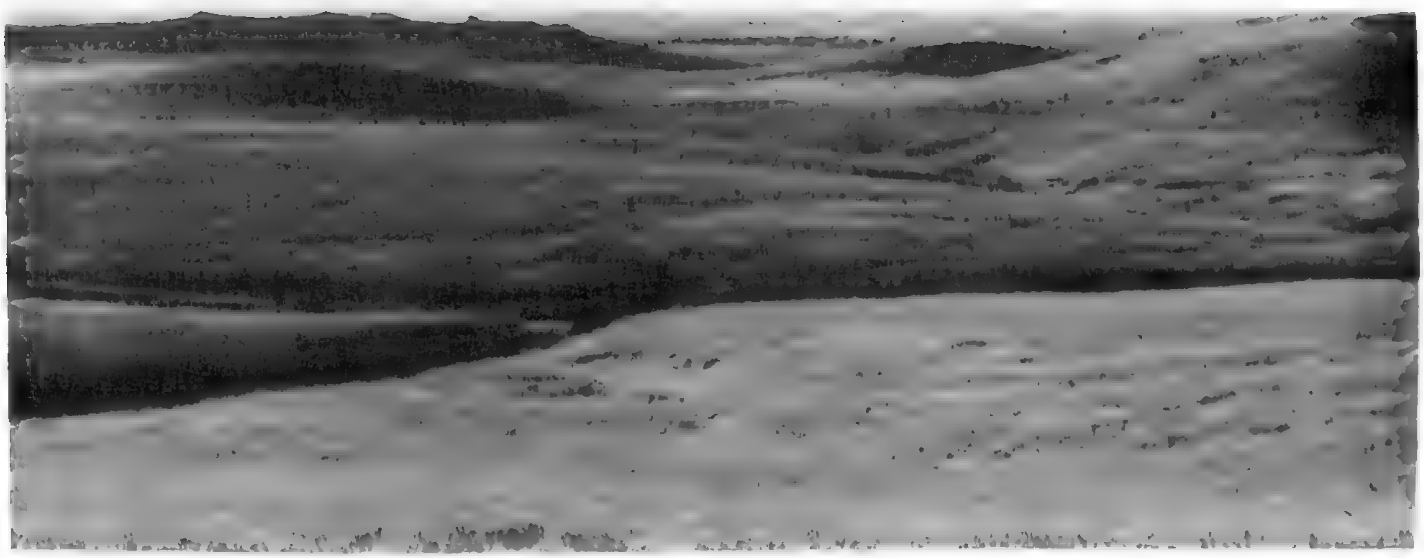


Figure 8.—An area of the Lancaster-Hedville complex, 5 to 30 percent slopes, used as range.

Figure 9.—A spring developed in an area of Lancaster-Hedville complex, 5 to 30 percent slopes.

and tilth. Minimizing tillage and returning crop residue to the soil improve fertility, help to prevent surface crusting, and increase the rate of water infiltration.

Corn and grain sorghum are the principal irrigated crops. If gravity irrigation is used, some land leveling generally is needed before the irrigation water can be managed efficiently. Controlling the rate of water application conserves irrigation water.

This soil is poorly suited to dwellings because of the flooding. Dikes, levees, and other structures lessen this hazard. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected.

This soil is moderately well suited to septic tank absorption fields and sewage lagoons. The flooding is a hazard affecting septic tank systems. Levees reduce this hazard. Seepage is a limitation affecting sewage lagoons. It can be controlled by sealing the lagoon.

The land capability classification is I, dryland and irrigated, and the range site is Loamy Terrace.

Sa—Sarpy loamy fine sand, undulating. This deep, excessively drained soil is on stream terraces that are subject to rare flooding. Slope ranges from 0 to 5 percent. Individual areas are irregular in shape and range from 10 to about 160 acres in size.

Typically, the surface layer is grayish brown loamy fine sand about 6 inches thick. The substratum to a depth of about 60 inches is very pale brown. The upper part is loamy fine sand, the next part is fine sand, and the lower part is loamy fine sand.

Included with this soil in mapping are small areas of the loamy, well drained Cass and Eudora soils on the slightly lower flood plains. Also included are small areas of sandy, strongly sloping soils on uplands in the northern part of the county, near Clifton. Included soils make up less than 15 percent of the map unit.

Permeability is rapid in the Sarpy soil, and available water capacity is low. Runoff is slow. Tilth is good. Organic matter content is low.

About half of the acreage is used for cultivated crops, and half is used as range. This soil is poorly suited to dryland crops. Wheat is the main crop. The low available water capacity and soil blowing are the main concerns of management. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and maintain fertility.

This soil is suited to range. The dominant native vegetation is little bluestem, big bluestem, and prairie sandreed. Overgrazed areas are dominated by annual weeds. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland.

This soil is generally unsuitable for building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IVs, dryland, and the range site is Sandy Lowland.

Su—Sutphen silty clay loam, occasionally flooded. This deep, nearly level, moderately well drained soil is on stream terraces. Individual areas are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. The subsurface layer is very dark gray and dark gray, very firm silty clay about 29 inches thick. The next layer is dark gray, very firm silty clay about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown silty clay loam. In some areas the surface layer is silty clay. In others the subsurface layer is mottled. In places the depth to lime is more than 36 inches.

Included with this soil in mapping are small areas of the well drained Muir soils. These soils are in the slightly higher areas. They make up about 5 percent of the map unit.

Permeability is very slow in the Sutphen soil, and runoff is slow. Available water capacity is moderate. The shrink-swell potential is high. The surface layer is firm, and tilth is fair. If the soil is tilled when it is too wet or too dry, clods form and structure is destroyed.

Most areas are used for cultivated crops. This soil is well suited to wheat, sorghum, and soybeans. Planting and tilling are delayed during some wet periods. Also, the flooding can damage the crops. Drainage ditches help to remove excess surface water. The clayey subsoil restricts the movement of water into the soil and releases moisture slowly to plants. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, helps to maintain tilth, and increases the rate of water infiltration.

Corn and grain sorghum are the main irrigated crops. The main management concerns are the efficient use of irrigation water and maintenance of organic matter content, fertility, and tilth. Leaving crop residue on the surface helps to maintain tilth and fertility. Controlling the rate of water application helps to conserve irrigation water.

This soil is generally unsuitable for building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, dryland and irrigated, and the range site is Clay Lowland.

Tu—Tully silty clay loam, 2 to 7 percent slopes. This deep, moderately sloping, well drained soil is on slightly concave foot slopes. Individual areas are irregular in shape and range from 80 to 200 acres in size.

Typically, the surface soil is very dark gray silty clay loam about 12 inches thick. The subsoil is about 45 inches thick. The upper part is dark grayish brown, firm silty clay loam. The next part is dark grayish brown and grayish brown, very firm silty clay. The lower part is grayish brown, firm silty clay loam. The substratum to a depth of about 60 inches is brown silty clay loam. In places shale is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the shallow Kipson and Sogn soils. These soils are on side slopes above the Tully soil. They make up about 5 percent of the map unit.

Permeability is slow in the Tully soil, and runoff is medium. Available water capacity is high. The shrink-swell potential is high in the subsoil. Tilth is fair.

About half of the acreage is used for cultivated crops, and half is used as range. This soil is moderately well suited to wheat and grain sorghum. If cultivated crops are grown, erosion is a hazard. Terraces, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The dominant native vegetation is big bluestem, little bluestem, indiangrass, and switchgrass. Overused areas are dominated by blue grama, buffalograss, and sideoats grama. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the damage to buildings caused by shrinking and swelling.

Because of the slow permeability, this soil is generally unsuited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Slope is a limitation. If less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, dryland, and the range site is Loamy Upland.

We—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on convex or slightly concave side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface soil is dark grayish brown loam about 12 inches thick. The subsoil is about 30 inches thick. The upper part is brown, friable loam. The lower part is brown, firm or friable clay loam. The substratum to a depth of about 60 inches is light brown clay loam.

Included with this soil in mapping are small areas of the moderately deep Lancaster and shallow Hedville soils on the upper parts of side slopes. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Wells soil, and runoff is medium. Available water capacity is high. The shrink-swell potential is moderate in the subsoil. Tilth is good.

About half of the acreage is cultivated, and half is used as range. This soil is moderately well suited to wheat and sorghum. Erosion is a hazard if the soil is used for cultivated crops. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The dominant native vegetation is big bluestem, little bluestem, indiangrass, and switchgrass. In overused areas the more productive grasses are replaced by sideoats grama, tall dropseed, and blue grama. Proper stocking rates and a uniform distribution of grazing help to keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland.

This soil is well suited to dwellings; however, the shrink-swell potential is a limitation. Properly designing and reinforcing foundations and footings help to prevent the structural damage caused by shrinking and swelling.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage is a limitation affecting sewage lagoons. It can be controlled by sealing the lagoon. If less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, dryland, and the range site is Loamy Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well-managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 7 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 342,000 acres in Clay County, or nearly 82 percent of the total acreage, meets the soil requirements for prime farmland. Nearly all areas in the Crete-Hobbs and Muir-Eudora soil associations are prime farmland. These associations are described under the heading "General Soil Map Units." Prime farmland also occurs as scattered areas in other parts of the county. Most of the prime farmland is used as cropland, some of which is irrigated.

The map units in the survey area that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The Gibbon soil on the following list qualifies for prime farmland only in areas where the seasonal high water table has been sufficiently lowered by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the soil requirements for prime farmland are:

Cg	Cass fine sandy loam, occasionally flooded
Cr	Crete silt loam, 0 to 1 percent slopes
Cs	Crete silt loam, 1 to 3 percent slopes
Ct	Crete silty clay loam, 3 to 7 percent slopes

Er	Eudora very fine sandy loam, 2 to 5 percent slopes
Eu	Eudora loam, occasionally flooded
Gc	Geary silt loam, 2 to 7 percent slopes
Gm	Gibbon loam, occasionally flooded (where drained)
Ho	Hobbs silt loam, occasionally flooded
Hr	Holder silt loam, 3 to 7 percent slopes
Lc	Lancaster loam, 3 to 7 percent slopes
Mu	Muir silt loam
Su	Sutphen silty clay loam, occasionally flooded
Tu	Tully silty clay loam, 2 to 7 percent slopes
We	Wells loam, 3 to 7 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to land capability subclasses and range sites at the end of each map unit description and in tables 5 and 6. The interpretive groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

John C. Dark, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed in table 5.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 65 percent of the total acreage in Clay County is used for cultivated crops or tame hay, and about 2 percent is used for bromegrass pasture. In 1980 and 1981, wheat was grown on 38 percent of the cropland, sorghum on 28 percent, corn on 6 percent, alfalfa on 5 percent, tame hay on 4 percent, and soybeans on 2 percent (*3*). Oats, barley, and rye are grown on a minor acreage in the county. The acreage used for wheat and soybeans has increased during the past few years, while the acreage used for alfalfa has decreased.

About 14,000 acres in Clay County is irrigated. The irrigated areas are mainly in the valley of the Republican River. Corn and sorghum are the principal irrigated crops.

The main concerns in managing cultivated areas are controlling erosion and maintaining fertility, tilth, and organic matter content.

Erosion is the major problem on 75 percent of the cropland in Clay County. If the slope is more than 1 percent, erosion is a hazard. Benfield, Crete, Eudora, Geary, Lancaster, Tully, and Wells are arable soils that have a slope of more than 1 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Crete soils. Second, erosion results in the pollution of streams by sediment. Control of erosion

helps to prevent this pollution and thus improves the quality of water.

Erosion-control practices provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps crop residue on the surface for extended periods helps to control erosion and preserves the productive capacity of the soil.

Terraces and diversions reduce the length of slopes and thus help to control runoff and erosion. They are most practical on deep, well drained soils that have uniform, regular slopes. Contour tillage generally should be used in combination with terraces. It is best suited to soils that have smooth, uniform slopes and are suitable for terracing.

Soil tilth is the physical condition of the soil, especially soil structure, as related to the growth of plants. It affects water infiltration and seedbed preparation. Soils with good tilth are granular and porous. Tilth is a major concern on all soils, particularly Crete soils and the eroded soils in which the clayey subsoil has been mixed into the surface layer. Through its effect on water infiltration, tilth affects crop production. An increased rate of water infiltration increases the amount of water available to plants.

Soil tests should be made to determine the need for soil amendments, such as lime and fertilizer. The crops to be grown, the expected level of yields, and the experience of farmers should be considered before soil amendments are added. The Cooperative Extension Service can help to determine the kind and amount of nutrients needed.

The main concerns in managing the soils for tame grass pasture are maintaining or improving the quality of forage, controlling erosion, and reducing water loss. Proper stocking rates, rotation grazing, proper location of water and salt, applications of fertilizer, and control of unwanted vegetation help to maintain a good stand of tame grasses. The main tame grass grown in Clay County is smooth bromegrass.

Further information about management of cropland or pasture can be obtained from the local representative of the Soil Conservation Service or the Cooperative Extensive Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Rangeland

About 114,728 acres in Clay County, or 28 percent of the total acreage, is rangeland. Almost 45 percent of the agricultural income in the county is derived from the sale of livestock, principally cattle.

Many of the livestock enterprises are small stock farms. These farms are dominant in the northern and eastern parts of the county, where small tracts of rangeland are interspersed among larger areas of cropland. Ranches are dominant in the southwestern part of the county, where the tracts of rangeland tend to be larger and more continuous.

On a large percentage of the farms and ranches, the forage produced by grassland is supplemented by cool-season bromegrass pastures and grain sorghum crop residue. In some areas it is supplemented by small grain winter pastures. During the winter it generally is supplemented by hay and by protein concentrates.

Soils strongly influence the potential natural plant community in all areas of the county. The soils and climate of the county generally are suited to tall prairie grasses. The natural plant community is dominated by bluestems, indiangrass, and switchgrass. The southwestern part of the county, which is underlain by the Dakota Sandstone Formation, can support a somewhat unique natural plant community. It is a transitional zone between the Mixed Prairie farther to the west and the Tall Grass Prairie to the east. The dominant grass species, however, are most like those on the Tall Grass Prairie.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants (fig. 10). The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Figure 10.—Cattle grazing in an area of Lancaster soils used for range. The range site is Loamy Upland.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Forage production has been reduced in some areas in Clay County because the natural plant community has been depleted by excessive, continuous grazing and by the invasion of woody species on once open prairies. Proper grazing use and a uniform distribution of grazing help to maintain forage production. Rangeland can be improved by deferring grazing, alternately grazing and resting the pastures, controlling brush, and reseeding marginal cropland.

Windbreaks, Environmental Plantings, and Native Woodland

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

About 2 percent of the acreage in Clay County is forested. The woodland occurs as irregular tracts and narrow bands along stream and riverbanks, as narrow bands on steep breaks paralleling the rivers, and as strips along upland drainageways.

The woodland is divided into two main forest cover types—the hackberry-American elm-green ash and the bur oak. The hackberry-American elm-green ash forest

cover type is on bottom land in the Muir-Eudora soil association and along upland drainageways in areas of the other associations. This forest cover type often succeeds cottonwood, which is short lived and cannot regenerate in shade. Old and very large cottonwoods are common along the rivers. Other associated species are black walnut, bur oak, mulberry, boxelder, honeylocust, and Kentucky coffeetree. The upland drainageways support most of the bottom land species and support more black willow, osageorange, and Siberian elm than the areas on bottom land.

The bur oak forest cover type is in steep areas of the Geary-Holder soil association. Bur oak is dominant on these slopes. Hackberry, American elm, eastern redcedar, green ash, chinkapin oak, osageorange, and buckbrush are among the associated species.

Many of the trees on the bottom land have good potential for Christmas trees and for the production of veneer, sawtimber, firewood, and other wood products. Only a small part of the woodland, however, is managed for commercial wood production. Most of the wooded areas are privately owned tracts making up only a small acreage of the farms.

Trees and shrubs grow on most farmsteads and ranch headquarters in Clay County. They were planted at various times by the landowners after the farmsteads and ranches were established. Eastern redcedar and Siberian elm are the most common species in the windbreaks. Other species include green ash, hackberry, silver maple, ponderosa pine, and lilac.

Tree planting around the farmstead is a continuing need because old trees pass maturity and deteriorate, because some trees are destroyed by insects, disease, or storms, and because new plantings are needed in areas where farming or ranching is expanding.

Many field windbreaks are established throughout the county. They generally are hedgerows of osageorange. They were planted as property lines and field boundaries, as living fences, and as a source of wood for posts. Many hedgerows have been removed because fields are being enlarged.

A few shelterbelts are established in the county, mainly in the northeastern part. They consist of 8 to 10 rows of trees and shrubs. The most common species are eastern redcedar, green ash, ponderosa pine, hackberry, honeylocust, Russian mulberry, and American plum.

In order for windbreaks to fulfill their intended purpose, the soils on the site should be suited to the trees and shrubs selected for planting. Selecting suitable species helps to ensure survival and a maximum growth rate. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate.

Trees and shrubs generally can be easily established in Clay County. The survival rate can be restricted, however, mainly by competition from weeds and grasses and by dry conditions. The main management needs are proper site preparation before the trees or shrubs are planted and measures that control competing vegetation after the trees and shrubs are planted. Supplemental watering may be needed during dry periods.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Clay County has several areas of scenic, geologic, and historic interest. Public recreation facilities are available at the Milford Reservoir for camping, picnicking, boating, fishing, and hunting. Several thousand acres of land and water are open for public hunting around the upper end of the reservoir. Pheasant, bobwhite quail, and waterfowl hunting seasons draw large numbers of hunters to the county.

Nature trails and the Kansas Landscape Arboretum at Wakefield are enjoyed by many visitors annually. Farm ponds, the Republican River, and several smaller streams provide opportunities for water sports.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to drinking water, potential water

impoundment sites, and access to public sewerlines or other disposal systems. The capacity of the soil to absorb septic tank effluent or its suitability for sewage lagoons and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Clay County are pheasant, bobwhite quail, mourning dove, cottontail rabbit, prairie chicken, and white-tailed deer. Waterfowl on the Milford Reservoir and farm ponds also are hunted.

Nongame species are numerous because of the diversity of habitat types in the county. Cropland, woodland, and grassland are interspersed throughout the county. The development of additional areas where habitat types are interspersed generally attracts more wildlife.

Furbearers are common along many of the streams. They are trapped on a limited basis.

The Milford Reservoir and ponds and streams within Clay County provide good to excellent fishing. The species commonly caught are largemouth bass, bluegill, crappie, carp, channel cat, and flathead catfish. Walleye, northern pike, and white and striped bass also are caught in the reservoir.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, grain sorghum, soybeans, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestems, indiangrass, switchgrass, ragweed, sunflowers, goldenrod, wheatgrass, native legumes, and gramagrass.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are prairie rose, dogwood, buckbrush, gooseberry, blackberry, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, ponds, and lakes.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, and cottontail rabbit.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas (fig. 11). Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbirds, muskrat, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, jackrabbits, hawks, meadowlarks, and prairie chickens.

Technical assistance in planning wildlife areas and in determining the vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

John Eberwein, civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure

Figure 11.—Habitat for ducks and other species of wetland wildlife in an area of Calco soils at the upper end of the Milford Reservoir.

aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance

are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and

bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime, fly ash, or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable

source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse

texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 12). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

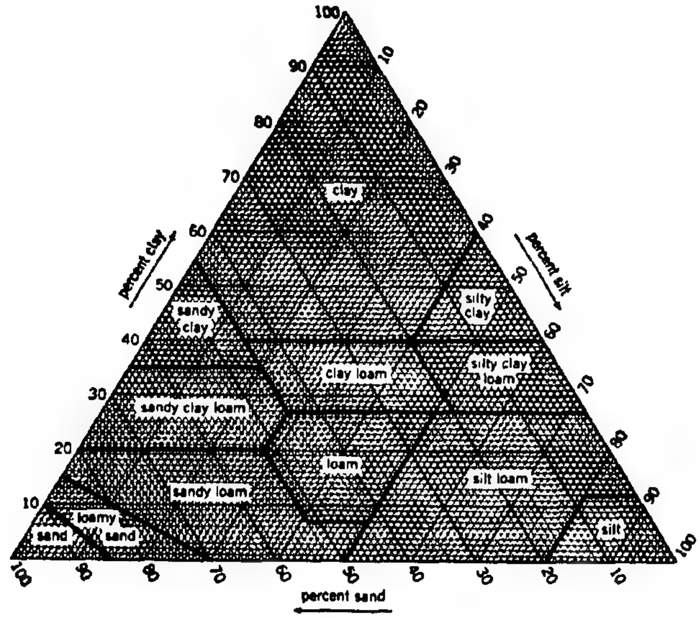


Figure 12.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme soils in

group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to absorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type

of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or

soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*6*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiustolls (*Argi*, meaning argillic horizon, plus *ustolls*, the suborder of the Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thicker surface layer than is typical for the great group. An example is Pachic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Pachic Argiustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*5*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*6*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Benfield Series

The Benfield series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in shale residuum. Slope ranges from 3 to 7 percent.

The Benfield soils in Clay County are taxadjuncts to the Benfield series because they typically have lime nearer the surface than is defined as the range for the series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Benfield soils are similar to Edalgo soils and are commonly adjacent to Crete soils. Edalgo soils do not have carbonates within the solum. Crete soils are more than 40 inches deep over bedrock. They are on ridgetops and the upper side slopes.

Typical pedon of Benfield silty clay loam, 3 to 7 percent slopes, 1,500 feet east and 400 feet north of the southwest corner of sec. 30, T. 7 S., R. 4 E.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, firm; many fine roots; neutral; clear smooth boundary.

Bt1—10 to 18 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong medium blocky structure; hard, very firm; common fine roots; mildly alkaline; gradual smooth boundary.

Bt2—18 to 24 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate fine blocky structure; hard, very firm; few fine roots; moderately alkaline; gradual smooth boundary.

2BC—24 to 32 inches; yellowish brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; hard, very firm; few fine lime concentrations; moderately alkaline; clear smooth boundary.

2Cr—32 inches; very pale brown (10YR 7/4) shale.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The mollic epipedon is 7 to 20 inches thick. The depth to carbonates is 20 to 36 inches. Carbonates are only in the form of concretions within a depth of 28 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The Bt horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is silty clay or silty clay loam. It ranges from neutral to moderately alkaline.

Calco Series

The Calco series consists of deep, very poorly drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Calco soils are commonly adjacent to Eudora soils. These adjacent soils are well drained and are in the slightly higher areas.

Typical pedon of Calco silty clay loam, frequently flooded, 2,300 feet east and 1,400 feet south of the northwest corner of sec. 18, T. 9 S., R. 4 E.

A—0 to 30 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium granular structure; hard, friable; common fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

AC—30 to 44 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; common fine faint yellowish brown (10YR 5/4) mottles; massive; slightly hard, friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Cg—44 to 60 inches; light gray (10YR 7/2) and light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) moist; many medium distinct brownish yellow (10YR 6/6) mottles; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The mollic epipedon ranges from 30 to 50 inches in thickness. The A horizon has hue of 10YR, value of 3 or 4 (2 moist), and chroma of 1. It is dominantly silty clay loam, but the range includes silt loam. This horizon is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 1 or 2.

Cass Series

The Cass series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in loamy alluvium over sandy alluvium. Slope ranges from 0 to 2 percent.

Cass soils are similar to Eudora soils and are commonly adjacent to Eudora and Sarpy soils. Eudora soils are less sandy than the Cass soils. Sarpy soils are more sandy than the Cass soils. They are on mounds.

Typical pedon of Cass fine sandy loam, occasionally flooded, 700 feet west and 50 feet north of the southeast corner of sec. 27, T. 8 S., R. 3 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; neutral; clear smooth boundary.

A—7 to 18 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; neutral; gradual smooth boundary.

AC—18 to 28 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; few fine roots; neutral; gradual smooth boundary.

C1—28 to 42 inches; light brownish gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; single grained; soft, very friable; mildly alkaline; gradual smooth boundary.

C2—42 to 60 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes loam. This horizon ranges from medium acid to neutral. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It ranges from slightly acid to mildly alkaline.

Crete Series

The Crete series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 0 to 8 percent.

Crete soils are similar to Tully soils and are commonly adjacent to Geary, Hobbs, and Holder soils. The well drained Tully soils formed in colluvium. Geary and Holder soils have a subsoil that is less clayey than that of the Crete soils. They are on the lower side slopes below the Crete soils. Hobbs soils are on flood plains. They do not have a mollic epipedon or an argillic horizon.

Typical pedon of Crete silt loam, 1 to 3 percent slopes, 800 feet west and 2,100 feet south of the northeast corner of sec. 31, T. 9 S., R. 3 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

AB—7 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, firm; many fine roots; slightly acid; clear smooth boundary.

Bt1—12 to 22 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure parting to strong fine blocky; very hard, very firm; common fine roots; neutral; gradual smooth boundary.

Bt2—22 to 28 inches; brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate fine blocky structure; very hard, very firm; few very fine roots; mildly alkaline; gradual smooth boundary.

Bt3—28 to 36 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; weak fine blocky structure; hard, firm; few very fine roots; few fine lime concretions; mildly alkaline; gradual smooth boundary.

C—36 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; few fine distinct yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) mottles; massive; hard, firm; few fine lime concretions; mildly alkaline.

The thickness of the solum range from 30 to 42 inches. The mollic epipedon is 20 to 30 inches thick. In most pedons the depth to lime is 25 to 40 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is silt loam or silty clay loam. It is medium acid or slightly acid. The Bt horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4.

Edalgo Series

The Edalgo series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in shale residuum. Slope ranges from 4 to 8 percent.

Edalgo soils are similar to Benfield soils and are commonly adjacent to Crete, Hedville, and Lancaster soils. Benfield soils have lime within the solum. Crete soils do not have bedrock within a depth of 40 inches. They are on ridgetops and the upper side slopes. Hedville soils are less than 20 inches deep over sandstone. They are on the steeper, upper side slopes and narrow ridgetops. Lancaster soils have a loamy subsoil. They are on ridgetops or side slopes above the Edalgo soils.

Typical pedon of Edalgo silty clay loam, 4 to 8 percent slopes, 1,100 feet south and 700 feet west of the northeast corner of sec. 18, T. 9 S., R. 2 E.

A—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, firm; many fine roots; medium acid; gradual smooth boundary.

Bt1—10 to 16 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; hard, very firm; common fine roots; few small ironstone fragments; medium acid; gradual smooth boundary.

Bt2—16 to 28 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very hard, very firm; few fine roots; few small ironstone fragments; slightly acid; gradual smooth boundary.

BC—28 to 34 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, very firm; few fine lime concretions; few small ironstone fragments; mildly alkaline; clear smooth boundary.

Cr—34 inches; light gray (10YR 7/2) and yellow (10YR 7/6) shale; few fine accumulations of gypsum.

The thickness of the solum and the depth to shale range from 20 to 40 inches. The mollic epipedon is 8 to 18 inches thick. The solum ranges from medium acid to neutral.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes loam and clay loam. The Bt horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is silty clay or silty clay loam. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 8. It is silty clay, clay, or silty clay loam. Some pedons do not have a C horizon. Others do not have carbonate concretions in this horizon.

Eudora Series

The Eudora series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in silty and loamy alluvium. Slope ranges from 0 to 5 percent.

Eudora soils are similar to Cass, Haynie, and Muir soils and are commonly adjacent to Cass, Muir, and Sarpy soils. Cass and Sarpy soils contain more sand than the Eudora soils. Cass soils are in landscape positions similar to those of the Eudora soils. Sarpy soils are on mounds and are higher on the landscape than the Eudora soils. Haynie soils do not have a mollic epipedon. Muir soils contain more clay in the subsoil than the Eudora soils.

Typical pedon of Eudora loam, occasionally flooded, 600 feet east and 200 feet north of the southwest corner of sec. 20, T. 6 S., R. 2 E.

Ap—0 to 7 inches; gray (10YR 5/1) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; many fine roots; neutral; abrupt smooth boundary.

A—7 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; many fine roots; neutral; abrupt smooth boundary.

C1—10 to 20 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; common very fine roots; neutral; clear smooth boundary.

C2—20 to 28 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; few very fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

C3—28 to 60 inches; light gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; slight effervescence; mildly alkaline.

The thickness of the solum and of the mollic epipedon ranges from 10 to 24 inches. The depth to lime ranges from 20 to more than 60 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is loam, very fine sandy loam, or silt loam. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. It ranges from neutral to moderately alkaline. In some pedons it has thin strata of loamy fine sand or silty clay loam.

Geary Series

The Geary series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slope ranges from 2 to 15 percent.

Geary soils are similar to Holder and Wells soils and are commonly adjacent to Crete, Holder, and Muir soils. Holder soils do not have hues as red as 7.5YR in the subsoil. Wells soils contain more sand in the subsoil than the Geary soils. Crete soils have a clayey subsoil. They are higher on the landscape than the Geary soils. Muir soils do not have an argillic horizon. They are on terraces.

Typical pedon of Geary silt loam, 2 to 7 percent slopes, 900 feet east and 1,200 feet south of the northwest corner of sec. 23, T. 8 S., R. 3 E.

Ap—0 to 7 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; hard, friable; many fine roots; medium acid; clear smooth boundary.

BA—7 to 10 inches; reddish brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; hard, friable; common fine roots; slightly acid; gradual smooth boundary.

Bt1—10 to 24 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; moderate fine blocky structure; very hard, firm; common fine roots; neutral; gradual smooth boundary.

Bt2—24 to 32 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; weak medium blocky structure; very hard, firm; few very fine roots; neutral; gradual smooth boundary.

BC—32 to 38 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, friable; neutral; gradual smooth boundary.

C—38 to 60 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 5/4) moist; massive; hard, friable; mildly alkaline.

The thickness of the solum ranges from 30 to 60 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is silt loam or silty clay loam. The Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (4 or 5 moist), and chroma of 3 to 6. It is silt loam, silty clay loam, or clay loam. It ranges from neutral to moderately alkaline.

Gibbon Series

The Gibbon series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in calcareous alluvium. Slope is 0 to 1 percent.

Gibbon soils are commonly adjacent to Eudora soils. These adjacent soils contain less clay in the subsoil than the Gibbon soils. They are well drained and are on the slightly higher flood plains.

Typical pedon of Gibbon loam, occasionally flooded, 1,200 feet north and 75 feet west of the southeast corner of sec. 18, T. 6 S., R. 2 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; common fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

A—7 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium granular structure; slightly hard, friable; common fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Bk1—14 to 24 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few fine accumulations of lime; few fine nests of salt crystals; violent effervescence; mildly alkaline; clear smooth boundary.

Bk2—24 to 36 inches; light brownish gray (10YR 6/2) very fine sandy loam, grayish brown (10YR 5/2) moist; common fine faint yellowish brown (10YR 5/4) mottles; massive; slightly hard, friable; few fine roots; few fine accumulations of lime; few fine nests of salt crystals; violent effervescence; mildly alkaline; gradual smooth boundary.

C1—36 to 50 inches; light gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) moist; few medium faint dark yellowish brown (10YR 4/4) mottles; massive; soft, very friable; violent effervescence; moderately alkaline; clear smooth boundary.

C2—50 to 60 inches; light brownish gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; single grained; loose; few thin strata of loamy fine sand; slight effervescence; moderately alkaline.

The solum ranges from 14 to 36 inches in thickness. It is mildly alkaline or moderately alkaline. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly loam, but the range includes silt loam and silty clay loam. The Bk and C horizons have hue of 10YR, value of 5 to 8 (4 to 6 moist), and chroma of 1 or 2. The C horizon is very fine sandy loam or loam in the upper part and fine sand or loamy fine sand in the lower part.

Haynie Series

The Haynie series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope ranges from 0 to 2 percent.

Haynie soils are similar to Eudora soils and are commonly adjacent to Sarpy soils. Eudora soils have a mollic epipedon. Sarpy soils are sandy and are in undulating areas.

Typical pedon of Haynie silt loam, in an area of Haynie-Sarpy complex, occasionally flooded, 4,100 feet north and 1,800 feet east of the southwest corner of sec. 18, T. 8 S., R. 3 E.

A—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

C1—6 to 18 inches; stratified grayish brown (10YR 5/2) silt loam and light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) moist; massive; slightly hard, friable; many fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

C2—18 to 60 inches; light brownish gray (10YR 6/2) very fine sandy loam, grayish brown (10YR 5/2) moist; few fine faint light yellowish brown (10YR 6/4) mottles; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The solum is less than 10 inches thick. The depth to lime ranges from 0 to 10 inches.

The A horizon has hue of 10YR, value of 4 or 5 (3 moist), and chroma of 2. It is dominantly silt loam, but the range includes very fine sandy loam and silty clay loam. The C horizon is silt loam or very fine sandy loam.

Hedville Series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone. Slope ranges from 5 to 30 percent.

Hedville soils are similar to Sogn soils and are commonly adjacent to Edalgo, Lancaster, and Wells soils. Edalgo and Lancaster soils are 20 to 40 inches deep over bedrock. Their positions on the landscape are similar to those of the Hedville soils. Sogn soils are shallow over limestone bedrock. Wells soils are more

than 40 inches deep over bedrock. They are on slopes below the Hedville soils.

Typical pedon of Hedville cobbly loam, in an area of Lancaster-Hedville complex, 5 to 30 percent slopes, 1,800 feet north and 300 feet east of the southwest corner of sec. 36, T. 8 S., R. 1 E.

A—0 to 14 inches; dark grayish brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable; many fine roots; slightly acid; clear wavy boundary.

R—14 inches; brown sandstone.

The thickness of the solum ranges from 4 to 20 inches. It is commonly the same as the depth to sandstone. The soils range from medium acid to neutral. The content of coarse fragments 1 to 10 inches in diameter ranges from 0 to 35 percent.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly cobbly loam, but the range includes loam and sandy loam. Some pedons have a thin B or C horizon between the mollic epipedon and the bedrock.

Hobbs Series

The Hobbs series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in stratified, silty alluvium (fig. 13). Slope ranges from 0 to 2 percent.

Hobbs soils are similar to Muir soils and are commonly adjacent to Crete, Geary, and Muir soils. Muir soils have a mollic epipedon. Crete and Geary soils have a mollic epipedon and an argillic horizon. They are on uplands.

Typical pedon of Hobbs silt loam, occasionally flooded, 2,300 feet east and 75 feet south of the northwest corner of sec. 25, T. 8 S., R. 3 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; mildly alkaline; clear smooth boundary.

C1—7 to 16 inches; stratified dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; moderate thin platy and moderate medium granular structure; slightly hard, friable; common fine roots; mildly alkaline; gradual smooth boundary.

C2—16 to 40 inches; stratified dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) moist; weak medium granular structure; slightly hard, friable; few very fine roots; mildly alkaline; gradual smooth boundary.

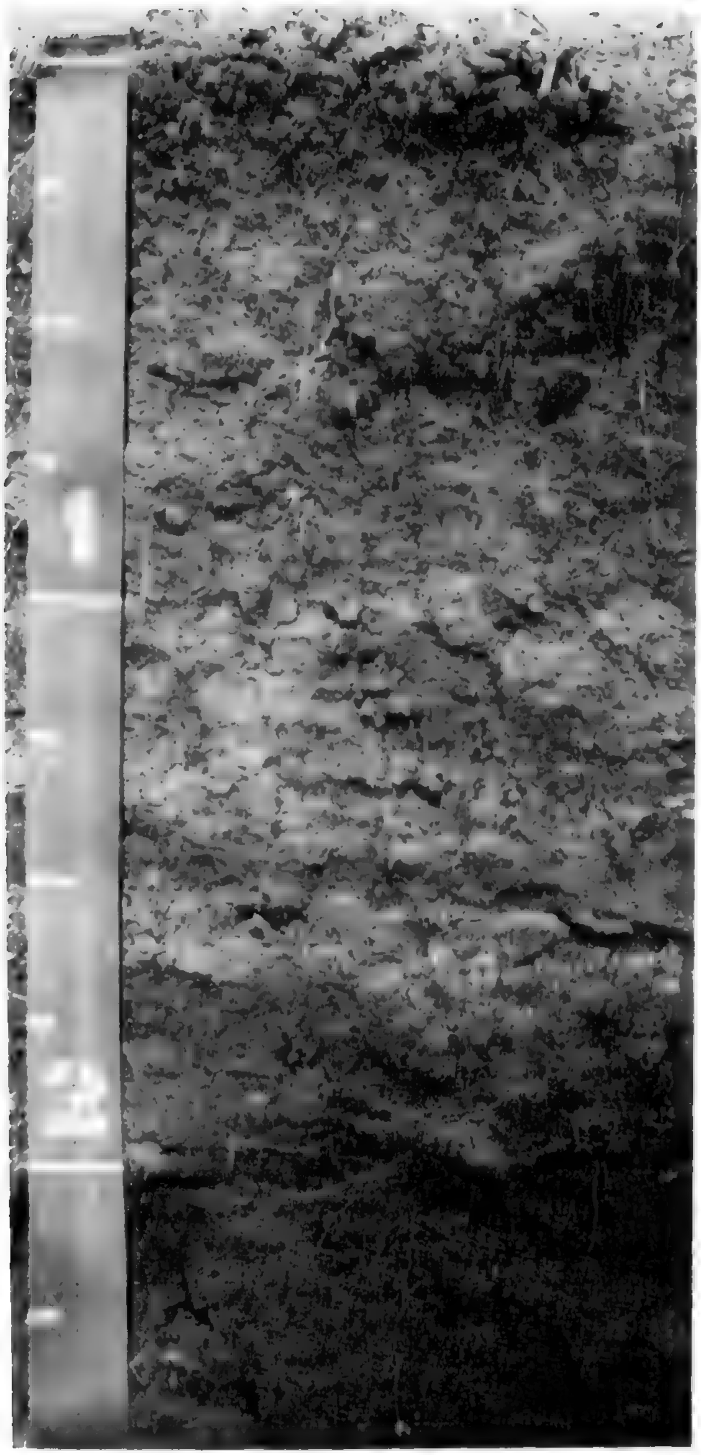


Figure 13.—Profile of Hobbs silt loam, which is stratified and has a buried soil at a depth of about 2 feet. Depth is marked in feet.

Ab—40 to 60 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable; neutral.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. This horizon ranges from slightly acid to mildly alkaline.

The C horizon has hue of 10YR, value of 4 to 7 (3 to 5 moist), and chroma of 1 or 2. It is dominantly silt loam or silty clay loam. In some pedons, however, it has thin strata of more clayey material in the lower part. It ranges from slightly acid to moderately alkaline. Some pedons do not have a buried horizon.

Holder Series

The Holder series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess (fig. 14). Slope ranges from 3 to 7 percent.

Holder soils are similar to Geary soils and are commonly adjacent to Crete and Geary soils. Geary soils have redder hue in the subsoil than the Holder soils. Crete soils have a clayey subsoil. They are higher on the landscape than the Holder soils.

Typical pedon of Holder silt loam, 3 to 7 percent slopes, 2,400 feet north and 100 feet west of the southeast corner of sec. 33, T. 8 S., R. 3 E.

A—0 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable; many fine roots; medium acid; clear smooth boundary.

BA—12 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; medium acid; gradual smooth boundary.

Bt1—18 to 30 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; slightly hard, firm; common fine roots; slightly acid; gradual smooth boundary.

Bt2—30 to 36 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; neutral; gradual smooth boundary.

BC—36 to 50 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.

C—50 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable; few soft accumulations of lime; slight effervescence; mildly alkaline.

Figure 14.—Profile of Holder silt loam. This soil formed in thick deposits of loess along the valley of the Republican River. Depth is marked in feet.

The thickness of the solum ranges from 25 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to carbonates ranges from 36 to 60 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from medium acid to neutral. The Bt horizon has hue of 10YR, value of 4 to 6 (4 or 5 moist), and chroma of 2 or 3. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (5 or 6 moist), and chroma of 2 or 3. It ranges from neutral to moderately alkaline.

Kipson Series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in calcareous shale residuum. Slope ranges from 5 to 20 percent.

Kipson soils are similar to Sogn soils and are commonly adjacent to Sogn and Tully soils. Sogn soils are shallow over limestone. Tully soils are more than 40 inches deep over bedrock. They are on foot slopes below the Kipson soils.

Typical pedon of Kipson silty clay loam, in an area of Kipson-Sogn silty clay loams, 5 to 20 percent slopes, 2,150 feet north and 2,650 feet east of the southwest corner of sec. 18, T. 10 S., R. 4 E.

A—0 to 8 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, friable; many fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

AC—8 to 12 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; violent effervescence; moderately alkaline; gradual smooth boundary.

C—12 to 18 inches; light gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) moist; weak fine subangular blocky structure; slightly hard, friable; many fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

Cr—18 inches; light gray (2.5Y 7/2) shale.

The solum and the mollic epipedon are 6 to 12 inches thick. The depth to shale ranges from 7 to 20 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes flaggy silty clay loam and silt loam. This horizon ranges from neutral to moderately alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6. It is silty clay loam or shaly silty clay loam. It is moderately alkaline or strongly alkaline.

Lancaster Series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone and sandy shale. Slope ranges from 3 to 12 percent.

Lancaster soils are similar to Wells soils and are commonly adjacent to Hedville and Wells soils. Hedville soils are 10 to 20 inches deep over bedrock. Wells soils are more than 40 inches deep over bedrock. They are on side slopes below the Lancaster soils.

Typical pedon of Lancaster loam, in an area of Lancaster-Hedville complex, 5 to 30 percent slopes, 1,700 feet north and 20 feet west of the southeast corner of sec. 30, T. 9 S., R. 1 E.

A—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

BA—9 to 18 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, firm; common fine roots; medium acid; gradual smooth boundary.

Bt—18 to 26 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, firm; few fine roots; slightly acid; gradual smooth boundary.

BC—26 to 35 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; clear smooth boundary.

Cr—35 inches; strong brown (7.5YR 5/6) sandstone and sandy shale.

The thickness of the solum and the depth to sandy shale bedrock range from 20 to 40 inches. The mollic epipedon is 8 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam, but the range includes sandy loam. This horizon is medium acid or slightly acid. The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. It is slightly acid or neutral.

Muir Series

The Muir series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in noncalcareous, silty alluvium. Slope ranges from 0 to 2 percent.

Muir soils are similar to Eudora and Hobbs soils and are commonly adjacent to Eudora, Hobbs, and Sutphen soils. Eudora soils contain less clay in the subsoil than the Muir soils. Hobbs soils do not have a mollic epipedon. Sutphen soils are more clayey than the Muir soils. They are in depressions.

Typical pedon of Muir silt loam, 1,200 feet south and 150 feet west of the northeast corner of sec. 22, T. 6 S., R. 1 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.
A—7 to 22 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.
Bw1—22 to 36 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate very fine blocky structure; hard, firm; common very fine roots; slightly acid; gradual smooth boundary.
Bw2—36 to 50 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.
C—50 to 60 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

The solum ranges from 24 to 55 inches in thickness. The thickness of the mollic epipedon ranges from 20 to 48 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from medium acid to neutral. The Bw horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay loam, silt loam, or loam. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is silt loam, silty clay loam, or loam. It ranges from slightly acid to mildly alkaline.

Sarpy Series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils on terraces and flood plains. These soils formed in sandy alluvium. Slope ranges from 0 to 5 percent.

Sarpy soils are commonly adjacent to Cass, Eudora, and Haynie soils. These adjacent soils are less sandy than the Sarpy soils and are slightly lower on the landscape.

Typical pedon of Sarpy loamy fine sand, undulating, 2,300 feet east and 2,000 feet south of the northwest corner of sec. 35, T. 8 S., R. 3 E.

A—0 to 6 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; many fine roots; neutral; clear smooth boundary.
C1—6 to 26 inches; very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) moist; single grained; loose; few fine roots; neutral; gradual smooth boundary.
C2—26 to 50 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; single grained; loose; mildly alkaline; gradual smooth boundary.
C3—50 to 60 inches; very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) moist; single grained; loose; mildly alkaline.

Reaction is neutral or mildly alkaline throughout the profile. The A horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is dominantly loamy fine sand, but the range includes fine sand and fine sandy loam. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is fine sand, loamy fine sand, or loamy sand. Some pedons have thin strata of finer textured material below a depth of 40 inches.

Sogn Series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone (fig. 15). Slope ranges from 5 to 20 percent.

Sogn soils are similar to Hedville and Kipson soils and are commonly adjacent to Kipson and Tully soils. Hedville soils are shallow over sandstone bedrock. Kipson soils are shallow over shale bedrock. Tully soils are more than 40 inches deep over bedrock. They are on foot slopes below the Sogn soils.

Typical pedon of Sogn silty clay loam, in an area of Kipson-Sogn silty clay loams, 5 to 20 percent slopes, 2,000 feet north and 2,650 feet east of the southwest corner of sec. 18, T. 10 S., R. 4 E.

A—0 to 12 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, friable; many fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.
R—12 inches; limestone.

The thickness of the solum and the depth to limestone range from 4 to 20 inches. The soils range from neutral to moderately alkaline.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam.

Sutphen Series

The Sutphen series consists of deep, moderately well drained, very slowly permeable soils on stream terraces along the Republican River. These soils formed in clayey and silty alluvium. Slope is 0 to 1 percent.

Sutphen soils are commonly adjacent to Muir soils. These adjacent soils have a silty subsoil. They are well

Figure 15.—Profile of Sogn silty clay loam. Limestone bedrock is at a depth of about 12 inches. Depth is marked in feet.

drained and are slightly higher on the landscape than the Sutphen soils.

Typical pedon of Sutphen silty clay loam, occasionally flooded, 1,600 feet south and 200 feet west of the northeast corner of sec. 1, T. 8 S., R. 2 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; weak medium granular structure; hard, firm; common fine roots; slightly acid; clear smooth boundary.

A1—7 to 22 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak medium blocky structure; very hard, very firm; few fine roots; neutral; gradual smooth boundary.

A2—22 to 36 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine blocky structure; very hard, very firm; few very fine roots; mildly alkaline; gradual smooth boundary.

ACy—36 to 46 inches; dark gray (10YR 4/1) silty clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; very hard, very firm; common fine lime concretions; common accumulations of gypsum; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard, very firm; few fine lime concretions and accumulations of gypsum; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The depth to lime concretions ranges from 20 to 36 inches. The mollic epipedon ranges from 24 to 48 inches in thickness.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is silty clay or silty clay loam.

Tully Series

The Tully series consists of deep, well drained, slowly permeable soils on foot slopes. These soils formed in a thick deposit of colluvial material weathered from shale. Slope ranges from 2 to 7 percent.

Tully soils are similar to Crete soils and are commonly adjacent to Kipson and Sogn soils. The moderately well drained Crete soils formed in loess. Kipson and Sogn soils are less than 40 inches deep over bedrock. They are on side slopes above the Tully soils.

Typical pedon of Tully silty clay loam, 2 to 7 percent slopes, 2,400 feet south and 150 feet west of the northeast corner of sec. 35, T. 9 S., R. 3 E.

A—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium granular structure; hard, friable; many fine roots; slightly acid; clear smooth boundary.

BA—12 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; many fine roots; neutral; clear smooth boundary.

Bt1—20 to 28 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; very hard, very firm; common fine roots; neutral; gradual smooth boundary.

Bt2—28 to 47 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure parting to weak fine blocky; very hard, very firm; common fine roots; neutral; gradual smooth boundary.

BC—47 to 57 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; few fine

faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; very hard, firm; few fine roots; few soft accumulations of lime; mildly alkaline; gradual smooth boundary.

C—57 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; few fine faint brownish yellow (10YR 6/6) mottles; massive; very hard, firm; few soft accumulations of lime; mildly alkaline.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is 20 to 36 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silty clay loam, but the range includes silt loam. This horizon ranges from medium acid to neutral. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay or clay. It ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It ranges from neutral to moderately alkaline.

Wells Series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium and in material weathered from noncalcareous sandstone and sandy shale. Slope ranges from 3 to 7 percent.

Wells soils are similar to Geary and Lancaster soils and are commonly adjacent to Hedville and Lancaster soils. Geary soils contain less sand in the subsoil than the Wells soils. Hedville and Lancaster soils are higher on the landscape than the Wells soils. Hedville soils are less than 20 inches deep over bedrock, and Lancaster soils are 20 to 40 inches deep over bedrock.

Typical pedon of Wells loam, 3 to 7 percent slopes, 700 feet west and 600 feet south of the northeast corner of sec. 32, T. 10 S., R. 1 E.

A—0 to 12 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

BA—12 to 18 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

Bt1—18 to 28 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate fine and medium blocky structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.

Bt2—28 to 36 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate fine blocky structure; hard, firm; common fine roots; slightly acid; gradual smooth boundary.

Bt3—36 to 42 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

C—42 to 60 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure; hard, friable; few fine roots on faces of peds; few sandstone pebbles; neutral.

The solum is 35 to 50 inches thick, and the mollic epipedon is 12 to 20 inches thick. The depth to bedrock is more than 40 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is medium acid or slightly acid. The Bt horizon has hue of 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. It is slightly acid or neutral. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (5 or 6 moist), and chroma of 4 to 6. It is loam, clay loam, sandy clay loam, or sandy loam. It is slightly acid or neutral.

Formation of the Soils

The characteristics of a soil at any given place are determined by the interactions among five factors of soil formation—parent material, climate, plant and animal life, relief, and time. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of the individual factors vary from place to place. The interactions among the factors are more complex for some soils than for others.

Climate and plant and animal life act on the parent material and gradually change it to a natural body of soil. Relief modifies the effects of climate and vegetation, mainly through its effect on runoff and temperature. The parent material affects the kind of soil that forms. Time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

Parent Material

The weathering of accumulated geologic material results in the parent material in which soils form. Parent material affects the texture and most other properties of the soil. The soils in Clay County formed in alluvium, colluvium, loess, and material weathered from limestone, shale, or sandstone.

Alluvium is sediment that was transported by water. Eudora, Hobbs, and Muir soils formed in silty or loamy alluvium. Sutphen soils formed in clayey and silty alluvium. Sarpy soils formed in sandy alluvium.

The colluvium in Clay County is sediment that accumulated at the base of the steeper slopes as a result of gravity. It is material weathered from shale. Tully soils formed in colluvial material.

Loess is silty, wind-deposited material, some of which has been carried hundreds of miles from its source. Crete soils formed in Peorian Loess, which was deposited during the Wisconsin glacial age. Geary soils formed in Loveland Loess, which was deposited during Illinoian time.

Most of the consolidated bedrock that crops out in Clay County is of the Cretaceous and Permian Systems. Edalgo, Hedville, Lancaster, and Wells are examples of soils that formed in material weathered from Cretaceous rocks (fig. 16). Kipson and Sogn soils formed in material weathered from Permian rocks.

Climate

Climate affects physical and chemical weathering and the biological forces at work in the parent material. The downward movement of water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends on the intensity of precipitation, the humidity, the relief, and the nature of the soil material. Soil-forming processes are most active when the soil is warm and moist. Soil structure is modified by freezing and thawing and by the frequent alternating wet and dry periods characteristic of the climate in the county.

Climate results in important differences among the soils throughout a wide region, but it results in only slight differences among soils in a smaller area, such as one the size of Clay County.

Plant and Animal Life

Plants and animals have important effects on soil formation. Plants generally affect the amount of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Bacteria and fungi help to decompose the plants, thus releasing more plant nutrients.

Tall prairie grasses have had the greatest influence on soil formation in Clay County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter.

Human activities also affect soil formation. Management that controls erosion is changing the relief and the surface and subsurface drainage pattern. Erosion and earthmoving in some areas have removed the original upper part of the soil, the part containing the highest amount of organic matter and nutrients. In this way, human activities have offset the normal process of soil formation.

Relief

Relief affects soil formation through its effect on drainage, runoff, plant cover, and soil temperature. Most important is the effect it has on the movement of water on the surface and into the soil.

Figure 16.—Lancaster and Hedville soils underlain by a thick sandstone layer that caps the upper ridges of the Dakota Formation. This exposure is along a county blacktop road about 3 miles east of Oak Hill.

Runoff is more rapid on the steeper soils in the uplands than on the less sloping soils. As a result, erosion is more extensive. Kipson and Sogn soils formed in the oldest parent material in the county, but they are not the most mature soils because relief has restricted soil formation. Runoff is rapid on the steep slopes, and much of the soil material is removed as a soil forms.

Time

The differences in the length of time that the parent materials have been in place are commonly reflected in the degree of profile development. Some soils form rapidly; others form slowly.

The soils of Clay County range from immature to mature. Those that are mature, for example Crete soils, have distinct horizons. Hobbs and other soils on low bottom land are considered immature. They are subject to stream overflow and receive new sediment with each flood. As a result, there has not been enough time for the formation of distinct horizons.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the

activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1941-70 at Clay Center, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	39.5	17.5	28.5	65	-12	0.86	0.13	1.25	2	6.0
February---	45.9	22.3	34.1	75	- 7	1.00	.26	1.73	3	5.7
March------	54.6	29.4	42.0	86	1	1.87	.59	2.43	4	3.9
April------	68.9	42.3	55.6	90	20	2.56	1.41	3.81	6	.6
May--------	77.7	52.9	65.3	96	30	4.30	2.37	5.67	7	.0
June-------	86.4	62.7	74.6	103	43	5.61	2.29	8.24	7	.0
July-------	91.9	67.2	79.6	106	48	4.25	1.65	6.07	6	.0
August-----	91.4	66.5	79.0	105	47	3.58	1.51	5.14	5	.0
September--	82.4	56.4	69.4	103	35	3.51	1.19	5.67	6	.0
October----	72.4	45.4	58.9	94	23	2.42	.42	3.67	4	.1
November---	55.4	31.2	43.3	77	4	.99	.10	2.37	3	1.8
December---	42.7	21.5	32.1	67	- 8	.96	.25	1.43	2	4.4
Year-----	67.4	42.9	55.2	107	-14	31.91	24.28	37.63	55	22.5

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1941-70 at Clay Center, Kansas]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 11	April 23	May 8
2 years in 10 later than--	April 6	April 18	May 3
5 years in 10 later than--	March 28	April 8	April 23
First freezing temperature in fall:			
1 year in 10 earlier than--	October 21	October 14	October 3
2 years in 10 earlier than--	October 25	October 19	October 7
5 years in 10 earlier than--	November 4	October 28	October 17

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1941-70 at Clay Center, Kansas]

Probability	Length of growing season if daily minimum temperature is --		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	202	184	155
8 years in 10	209	190	162
5 years in 10	221	203	177
2 years in 10	233	214	192
1 year in 10	240	221	199

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Be	Benfield silty clay loam, 3 to 7 percent slopes	3,850	0.9
Cb	Calco silty clay loam, frequently flooded	1,500	0.4
Cg	Cass fine sandy loam, occasionally flooded	4,800	1.1
Cr	Crete silt loam, 0 to 1 percent slopes	2,900	0.7
Cs	Crete silt loam, 1 to 3 percent slopes	120,800	28.6
Ct	Crete silty clay loam, 3 to 7 percent slopes	48,960	11.7
Cx	Crete silty clay loam, 3 to 8 percent slopes, eroded	48,100	11.5
Ed	Edalgo silty clay loam, 4 to 8 percent slopes	6,100	1.5
Er	Eudora very fine sandy loam, 2 to 5 percent slopes	800	0.2
Eu	Eudora loam, occasionally flooded	11,900	2.8
Gc	Geary silt loam, 2 to 7 percent slopes	32,300	7.7
Gf	Geary silt loam, 9 to 15 percent slopes	3,850	0.9
Gh	Geary silty clay loam, 4 to 9 percent slopes, eroded	6,700	1.6
Gm	Gibbon loam, occasionally flooded	600	0.1
He	Haynie-Sarpy complex, occasionally flooded	5,000	1.2
Hn	Hobbs silt loam, channeled	2,550	0.6
Ho	Hobbs silt loam, occasionally flooded	20,000	4.8
Hr	Holder silt loam, 3 to 7 percent slopes	2,250	0.5
Ks	Kipson-Sogn silty clay loams, 5 to 20 percent slopes	13,400	3.2
Lc	Lancaster loam, 3 to 7 percent slopes	5,100	1.2
Lh	Lancaster-Hedville complex, 5 to 30 percent slopes	24,300	5.8
Mu	Muir silt loam	35,100	8.4
Sa	Sarpy loamy fine sand, undulating	1,550	0.4
Su	Sutphen silty clay loam, occasionally flooded	3,700	0.9
Tu	Tully silty clay loam, 2 to 7 percent slopes	3,600	0.9
We	Wells loam, 3 to 7 percent slopes	4,450	1.1
	Water	5,450	1.3
	Total	419,610	100.0

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability		Winter wheat		Grain sorghum		Soybeans		Corn		Alfalfa hay	
	N	I	N	I	N	I	N	I	N	I	N	I
			Bu	Bu	Bu	Bu	Bu	Bu	Bu	Bu	Tons	Tons
Be----------------- Benfield	IVe	---	30	---	46	---	20	---	---	---	3.0	---
Cb----------------- Calco	Vw	---	---	---	---	---	---	---	---	---	---	---
Cg----------------- Cass	IIw	IIw	38	---	65	115	31	---	67	135	3.5	5.5
Cr----------------- Crete	IIs	---	41	---	71	---	29	---	---	---	3.2	---
Cs----------------- Crete	IIe	---	39	---	66	---	28	---	---	---	2.9	---
Ct----------------- Crete	IIIe	---	38	---	63	---	25	---	---	---	2.5	---
Cx----------------- Crete	IVe	---	35	---	59	---	21	---	---	---	2.2	---
Ed----------------- Edalgo	IVe	---	28	---	44	---	---	---	---	---	---	---
Er----------------- Eudora	IIe	IIe	40	---	75	---	35	---	85	120	4.0	5.5
Eu----------------- Eudora	IIw	IIw	44	---	79	120	39	---	95	138	4.1	5.5
Gc----------------- Geary	IIIe	---	37	---	70	---	29	---	---	---	3.0	---
Gf----------------- Geary	VIe	---	---	---	---	---	---	---	---	---	---	---
Gh----------------- Geary	IVe	---	35	---	62	---	23	---	---	---	---	---
Gm----------------- Gibbon	IIw	IIw	32	---	65	115	32	---	60	125	3.8	---
He----------------- Haynie-Sarpy	VIw	---	---	---	---	---	---	---	---	---	---	---
Hn----------------- Hobbs	Vw	---	---	---	---	---	---	---	---	---	---	---
Ho----------------- Hobbs	IIw	IIw	40	---	75	120	38	---	68	140	4.0	6.0
Hr----------------- Holder	IIIe	---	37	---	70	---	29	---	---	---	3.0	---
Ks----------------- Kipson-Sogn	VIe	---	---	---	---	---	---	---	---	---	---	---
Lc----------------- Lancaster	IVe	---	30	---	52	---	---	---	---	---	3.0	---
Lh----------------- Lancaster- Hedville	VIe	---	---	---	---	---	---	---	---	---	---	---

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability		Winter wheat		Grain sorghum		Soybeans		Corn		Alfalfa hay	
	N	I	N	I	N	I	N	I	N	I	N	I
			Bu	Bu	Bu	Bu	Bu	Bu	Bu	Bu	Tons	Tons
Mu---------------- Muir	I	I	45	---	80	130	38	44	95	145	5.0	7.0
Sa---------------- Sarpy	IVs	---	20	---	---	---	---	---	---	---	---	---
Su---------------- Sutphen	IIw	IIw	36	---	60	110	30	---	55	120	3.5	---
Tu---------------- Tully	IIIe	---	37	---	62	---	28	---	---	---	2.8	---
We---------------- Wells	IIIe	---	34	---	55	---	26	---	---	---	3.0	---

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Be: Benfield	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5
				Sideoats grama	5
Cb: Calco	Subirrigated	Favorable	6,300	Prairie cordgrass	25
		Normal	6,000	Reedgrass	25
		Unfavorable	5,800	Rush	10
				Canada wildrye	5
				Sedge	5
Cg: Cass	Sandy Lowland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Prairie sandreed	10
				Porcupinegrass	5
Cr, Cs, Ct, Cx: Crete	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Switchgrass	10
				Sideoats grama	10
				Indiangrass	5
				Tall dropseed	5
Ed: Edalgo	Clay Upland	Favorable	5,500	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
				Blue grama	5
Er: Eudora	Loamy Terrace	Favorable	7,000	Big bluestem	35
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Little bluestem	15
				Eastern gamagrass	10
				Switchgrass	5
Eu: Eudora	Loamy Lowland	Favorable	8,000	Big bluestem	35
		Normal	6,000	Indiangrass	15
		Unfavorable	5,000	Prairie cordgrass	10
				Eastern gamagrass	10
				Little bluestem	5
				Switchgrass	5
Gc, Gf, Gh: Geary	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5
Gm: Gibbon	Subirrigated	Favorable	6,300	Big bluestem	35
		Normal	5,900	Little bluestem	15
		Unfavorable	5,500	Indiangrass	10
				Prairie cordgrass	10
				Sedge	10
				Switchgrass	5
He*:					
Haynie	Loamy Lowland	Favorable	8,000	Big bluestem	40
		Normal	6,000	Indiangrass	15
		Unfavorable	5,000	Eastern gamagrass	10
				Switchgrass	10
				Little bluestem	5
				Prairie cordgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Compo- sition
		Kind of year	Dry weight		
			Lb/acre		Pct
He*:					
Sarpy	Sandy Lowland	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Prairie sandreed	15
				Indiangrass	5
				Porcupinegrass	5
Hn, Ho Hobbs	Loamy Lowland	Favorable	8,000	Big bluestem	40
		Normal	6,000	Indiangrass	15
		Unfavorable	5,000	Eastern gamagrass	10
				Little bluestem	5
				Switchgrass	5
				Prairie cordgrass	5
Hr Holder	Loamy Upland	Favorable	6,000	Big bluestem	40
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Switchgrass	10
				Indiangrass	5
				Eastern gamagrass	5
Ks*:					
Kipson	Limy Upland	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	25
		Unfavorable	3,000	Sideoats grama	15
				Switchgrass	5
				Indiangrass	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Big bluestem	15
		Unfavorable	1,500	Little bluestem	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
Lc Lancaster	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,300	Little bluestem	25
		Unfavorable	3,300	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Lh*:					
Lancaster	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,300	Little bluestem	25
		Unfavorable	3,300	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Hedville	Shallow Sandstone	Favorable	4,000	Little bluestem	35
		Normal	3,000	Big bluestem	30
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Mu Muir	Loamy Terrace	Favorable	7,000	Big bluestem	30
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Little bluestem	15
				Switchgrass	10
				Eastern gamagrass	5
Sa Sarpy	Sandy Lowland	Favorable	5,000	Big bluestem	30
		Normal	4,000	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Prairie sandreed	15
				Indiangrass	5
				Porcupinegrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Su: Sutphen	Clay Lowland	Favorable	7,500	Big bluestem	35
		Normal	5,500	Prairie cordgrass	25
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Eastern gamagrass	5
Tu: Tully	Loamy Upland	Favorable	6,000	Big bluestem	40
		Normal	4,400	Little bluestem	20
		Unfavorable	3,400	Switchgrass	10
				Indiangrass	10
				Eastern gamagrass	5
We: Wells	Loamy Upland	Favorable	6,000	Big bluestem	40
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Be----------------- Benfield	Siberian peashrub, Peking cotoneaster, lilac.	Amur honeysuckle, Manchurian crabapple.	Eastern redcedar, Austrian pine, Russian-olive, hackberry, green ash.	Siberian elm, honeylocust.	---
Cb----------------- Calco	Redosier dogwood--	Common chokecherry, American plum.	Hackberry, eastern redcedar.	Golden willow-----	Eastern cottonwood.
Cg----------------- Cass	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, hackberry, eastern white pine, honey- locust, bur oak, green ash.	Eastern cottonwood.
Cr, Cs, Ct, Cx---- Crete	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Austrian pine, Siberian peashrub.	Eastern redcedar, hackberry, Russian-olive, green ash.	Honeylocust, Siberian elm.	---
Ed----------------- Edalgo	Siberian peashrub, Amur honeysuckle, Peking cotoneaster.	Eastern redcedar, Rocky Mountain juniper, hackberry.	Austrian pine, honeylocust, Russian-olive, green ash, Russian mulberry.	Siberian elm------	---
Er----------------- Eudora	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, bur oak, eastern white pine, honeylocust, hackberry, green ash.	Eastern cottonwood.
Eu----------------- Eudora	---	Lilac, Peking cotoneaster, Amur honeysuckle, American plum.	Eastern redcedar	Austrian pine, bur oak, honeylocust, hackberry, green ash, eastern white pine.	Eastern cottonwood.
Gc, Gf, Gh-------- Geary	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, hackberry, bur oak, green ash, Russian-olive.	Scotch pine, Austrian pine, honeylocust.	---
Gm----------------- Gibbon	American plum-----	Common chokecherry	Eastern redcedar, hackberry, Austrian pine, green ash, Russian mulberry.	Golden willow, honeylocust.	Eastern cottonwood.
He*:					
Haynie------------	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
Sarpy-------------	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Washington hawthorn, Russian-olive, eastern redcedar, osageorange.	Hackberry, green ash, honeylocust, bur oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Hn, Ho---------- Hobbs	---	American plum, Peking cotoneaster, lilac, Amur honeysuckle.	Eastern redcedar	Green ash, hackberry, Austrian pine, honeylocust, eastern white pine, bur oak.	Eastern cottonwood.
Hr---------- Holder	Amur honeysuckle, lilac, fragrant sumac.	Russian mulberry	Eastern redcedar, Austrian pine, green ash, honeylocust, hackberry, bur oak, Russian-olive.	Siberian elm------	---
Ks*: Kipson.					
Sogn.					
Lc---------- Lancaster	Fragrant sumac, lilac, Siberian peashrub.	Rocky Mountain juniper, Russian mulberry, Russian-olive.	Eastern redcedar, green ash, Austrian pine, bur oak, honeylocust.	Siberian elm------	---
Lh*: Lancaster--------	Fragrant sumac, lilac, Siberian peashrub.	Rocky Mountain juniper, Russian mulberry, Russian-olive.	Eastern redcedar, green ash, Austrian pine, bur oak, honeylocust.	Siberian elm------	---
Hedville.					
Mu---------- Muir	---	Peking cotoneaster, Amur honeysuckle, American plum, lilac.	Eastern redcedar	Eastern white pine, honeylocust, bur oak, Austrian pine, green ash, hackberry.	Eastern cottonwood.
Sa---------- Sarpy	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub, Washington hawthorn.	Eastern redcedar, Russian-olive, osageorange.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
Su---------- Sutphen	Amur honeysuckle, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, hackberry, Russian-olive, green ash, Rocky Mountain juniper.	Austrian pine, Russian mulberry, honeylocust.	Siberian elm------	---
Tu---------- Tully	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
We---------- Wells	Peking cotoneaster	Fragrant sumac, Amur honeysuckle, lilac.	Russian-olive, eastern redcedar, hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Be-------------------- Benfield	Slight---------------	Slight---------------	Moderate: slope, small stones, depth to rock.	Slight.
Cb-------------------- Calco	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.
Cg-------------------- Cass	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Cr-------------------- Crete	Slight---------------	Slight---------------	Slight---------------	Slight.
Cs, Ct, Cx------------ Crete	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Ed-------------------- Edalgo	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight.
Er-------------------- Eudora	Severe: flooding.	Slight---------------	Moderate: slope.	Slight.
Eu-------------------- Eudora	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Gc-------------------- Geary	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Gf-------------------- Geary	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Gh-------------------- Geary	Slight---------------	Slight---------------	Severe: slope.	Slight.
Gm-------------------- Gibbon	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Moderate: wetness.
He*:				
Haynie----------------	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Sarpy-----------------	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Hn-------------------- Hobbs	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Ho-------------------- Hobbs	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Hr-------------------- Holder	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Ks*:				
Kipson----------------	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.	Slight.
Sogn------------------	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Lc-------------------- Lancaster	Slight---------------	Slight---------------	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lh*:				
Lancaster	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hedville	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: large stones, slope, small stones.	Moderate: slope.
Mu Muir	Severe: flooding.	Slight	Slight	Slight.
Sa Sarpy	Severe: flooding.	Slight	Moderate: slope.	Slight.
Su Sutphen	Severe: flooding.	Moderate: percs slowly.	Moderate: flooding, percs slowly.	Slight.
Tu Tully	Slight	Slight	Moderate: slope, small stones.	Slight.
We Wells	Slight	Slight	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Be----------------- Benfield	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Cb----------------- Calco	Poor	Fair	Good	Fair	Good	Good	Fair	Good	Fair.
Cg----------------- Cass	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Cr, Cs------------- Crete	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Ct, Cx------------- Crete	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Ed----------------- Edalgo	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Er----------------- Eudora	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Eu----------------- Eudora	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Gc----------------- Geary	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Gf----------------- Geary	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Gh----------------- Geary	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Gm----------------- Gibbon	Good	Good	Good	Good	Fair	Good	Good	Fair	Good.
He*:									
Haynie------------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Sarpy-------------	Poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Hn----------------- Hobbs	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Ho----------------- Hobbs	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Hr----------------- Holder	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Ks*:									
Kipson------------	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Sogn--------------	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
Lc----------------- Lancaster	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Lh*:									
Lancaster---------	Poor	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Hedville----------	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Mu----------------- Muir	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
Sa----------------- Sarpy	Fair	Poor	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
Su----------------- Sutphen	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Tu----------------- Tully	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
We----------------- Wells	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Be: Benfield	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cb: Calco	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.
Cg: Cass	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Cr, Cs, Ct, Cx: Crete	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ed: Edalgo	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Er: Eudora	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: frost action.
Eu: Eudora	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action.
Gc: Geary	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
Gf: Geary	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.
Gh: Geary	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
Gm: Gibbon	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, frost action.
He*:					
Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Hn, Ho: Hobbs	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Hr: Holder	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.
Ks*:					
Kipson	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ks*:					
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Lc: Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Lh*:					
Lancaster	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.
Hedville	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.
Mu: Muir	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Sa: Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
Su: Sutphen	Moderate: too clayey, flooding.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, flooding, shrink-swell.
Tu: Tully	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
We: Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Be------------------ Benfield	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Cb------------------ Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Cg------------------ Cass	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: thin layer.
Cr------------------ Crete	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
Cs, Ct, Cx---------- Crete	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
Ed------------------ Edalgo	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Er------------------ Eudora	Moderate: flooding.	Slight-----------	Moderate: flooding.	Moderate: flooding.	Good.
Eu------------------ Eudora	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Gc------------------ Geary	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Gf------------------ Geary	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Gh------------------ Geary	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Gm------------------ Gibbon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
He*:					
Haynie--------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Sarpy---------------	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Hn, Ho-------------- Hobbs	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Hr------------------ Holder	Slight-----------	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ks*:					
Kipson	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Lc Lancaster	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Lh*:					
Lancaster	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Hedville	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Mu Muir	Moderate: flooding.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Sa Sarpy	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Su Sutphen	Severe: flooding, percs slowly.	Slight	Severe: flooding, too clayey.	Severe: flooding.	Poor: too clayey, hard to pack.
Tu Tully	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
We Wells	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Be-------------------- Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Cb-------------------- Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cg-------------------- Cass	Good-----------------	Probable-------------	Improbable: too sandy.	Good.
Cr, Cs, Ct, Cx-------- Crete	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ed-------------------- Edalgo	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Er, Eu---------------- Eudora	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Good.
Gc-------------------- Geary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Gf-------------------- Geary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Gh-------------------- Geary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Gm-------------------- Gibbon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
He*:				
Haynie----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sarpy-----------------	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy.
Hn, Ho---------------- Hobbs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Hr-------------------- Holder	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ks*:				
Kipson----------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Sogn------------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Lc-------------------- Lancaster	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Lh*:				
Lancaster-------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lh*:				
Hedville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Mu Muir	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sa Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Su Sutphen	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Tu Tully	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
We Wells	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition; it does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Be----------------- Benfield	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Cb----------------- Calco	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness----------	Wetness.
Cg----------------- Cass	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing---	Favorable.
Cr, Cs------------- Crete	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily	Erodes easily, percs slowly.
Ct, Cx------------- Crete	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily	Erodes easily, percs slowly.
Ed----------------- Edalgo	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Er----------------- Eudora	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope------------	Erodes easily	Erodes easily.
Eu----------------- Eudora	Moderate: seepage.	Severe: piping.	Deep to water	Flooding--------	Erodes easily	Erodes easily.
Gc----------------- Geary	Moderate: seepage, slope.	Slight----------	Deep to water	Slope------------	Erodes easily	Erodes easily.
Gf----------------- Geary	Severe: slope.	Slight----------	Deep to water	Slope------------	Slope, erodes easily.	Slope, erodes easily.
Gh----------------- Geary	Moderate: seepage, slope.	Slight----------	Deep to water	Slope------------	Erodes easily	Erodes easily.
Gm----------------- Gibbon	Severe: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness----------	Favorable.
He*:						
Haynie-------------	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily, flooding.	Erodes easily	Erodes easily.
Sarpy--------------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Hn, Ho------------- Hobbs	Moderate: seepage.	Severe: piping.	Deep to water	Flooding--------	Favorable-------	Favorable.
Hr----------------- Holder	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope------------	Erodes easily	Erodes easily.
Ks*:						
Kipson-------------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ks*:						
Sogn	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock
Lc Lancaster	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Lh*:						
Lancaster	Severe: slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to roc
Hedville	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Droughty, depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to roc
Mu Muir	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
Sa Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Su Sutphen	Slight	Moderate: hard to pack.	Deep to water	Percs slowly, flooding.	Percs slowly	Percs slowly.
Tu Tully	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
We Wells	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Be-------------- Benfield	0-10	Silty clay loam	CL	A-6, A-7	0-15	85-100	85-100	85-95	85-95	30-50	11-25
	10-32	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-15	85-100	70-100	70-95	70-95	40-60	20-35
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cb-------------- Calco	0-30	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	30-60	Silt loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
Cg-------------- Cass	0-7	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-40	<20	NP-5
	7-28	Fine sandy loam, sandy loam, very fine sandy loam.	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-50	<20	NP-5
	28-60	Loamy fine sand, fine sand, coarse sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	50-75	5-30	---	NP
Cr, Cs---------- Crete	0-7	Silt loam--------	CL, ML	A-4, A-6	0	100	100	100	95-100	30-40	5-15
	7-36	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-65	25-40
	36-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Ct-------------- Crete	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-30
	7-31	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-65	25-40
	31-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Cx-------------- Crete	0-6	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-30
	6-28	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-65	25-40
	28-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Ed-------------- Edalgo	0-10	Silty clay loam	CL	A-6, A-7	0	95-100	85-100	75-100	60-95	30-45	10-25
	10-34	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	95-100	85-100	75-100	70-95	45-70	20-40
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
Er-------------- Eudora	0-7	Very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-98	20-35	2-11
	7-60	Silt loam, very fine sandy loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	10-25	NP-10
Eu-------------- Eudora	0-10	Loam------------	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-98	20-35	2-11
	10-60	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	10-25	NP-10
Gc-------------- Geary	0-10	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	10-38	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	38-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-22
Gf-------------- Geary	0-12	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	12-42	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	42-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-22

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Gh------------- Geary	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	75-98	35-45	15-25
	7-32	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	32-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-22
Gm------------- Gibbon	0-24	Loam------------	ML, CL, CL-ML	A-4	0	100	100	85-100	70-90	20-30	2-10
	24-50	Stratified fine sandy loam to silt loam.	SM, SC, CL, ML	A-4	0	100	100	70-95	35-90	<25	NP-8
	50-60	Fine sand--------	SP-SM, SP, SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
He*:											
Haynie----------	0-6	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	6-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
Sarpy-----------	0-6	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	6-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
Hn, Ho---------- Hobbs	0-7	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	7-60	Sandy loam, silty clay loam, very fine sandy loam.	CL, CL-ML, MH	A-4, A-6, A-7	0	100	100	95-100	80-100	25-55	5-25
Hr------------- Holder	0-12	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	98-100	90-100	20-40	2-16
	12-36	Silty clay loam	CL	A-6, A-7	0	100	100	98-100	95-100	35-50	20-35
	36-60	Silt loam, silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	95-100	90-100	30-45	5-20
Ks*:											
Kipson----------	0-8	Silty clay loam	CL, ML, MH, CH	A-6, A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	8-18	Shaly silt loam, silt loam, silty clay loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
Sogn------------	0-12	Silty clay loam	CL, MH, CH, ML	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lc------------- Lancaster	0-9	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-35	5-15
	9-35	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	95-100	80-95	40-65	25-45	8-25
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---
Lh*:											
Lancaster-------	0-9	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-35	5-15
	9-35	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	95-100	80-95	40-65	25-45	8-25
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hedville--------	0-14	Cobbly loam------	SM, ML, SC, CL	A-4, A-6	15-25	70-100	70-100	50-85	35-70	<35	NP-13
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Mu------------- Muir	0-22	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	100	95-100	85-100	20-35	4-15
	22-60	Silt loam, silty clay loam, loam.	CL, ML, CL-ML	A-4, A-6, A-7-6	0	100	100	95-100	85-100	20-45	4-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Sa---------------- Sarpy	0-6	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	6-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
Su---------------- Sutphen	0-7	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-55	20-35
	7-46	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	46-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	41-70	20-40
Tu---------------- Tully	0-20	Silty clay loam	CL, ML	A-6, A-7	0	100	75-100	75-100	70-95	35-50	10-25
	20-47	Silty clay, clay, cherty silty clay.	CH, CL	A-7	0	90-100	70-100	65-100	55-95	40-65	20-40
	47-60	Silty clay loam, clay, cherty silty clay.	CH, CL, SC	A-7	0	90-100	50-100	45-100	35-95	40-65	20-40
We---------------- Wells	0-18	Loam--------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-35	5-20
	18-42	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	42-60	Clay loam, loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cm3	In/hr	In/in	pH	mmhos/cm					Pct
Be---------------	0-10	20-35	1.30-1.40	0.2-2.0	0.21-0.24	6.1-7.8	<2	Moderate	0.37	3	7	1-4
Benfield	10-32	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	<2	High------	0.37			
	32	---	---	---	---	---	---	----------	----			
Cb---------------	0-30	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High------	0.32	5	6	5-7
Calco	30-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.32			
Cg---------------	0-7	7-17	1.40-1.60	2.0-6.0	0.16-0.18	5.6-7.3	<2	Low-------	0.20	5	3	1-2
Cass	7-28	5-15	1.40-1.60	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low-------	0.20			
	28-60	2-10	1.50-1.70	6.0-20	0.08-0.10	6.1-8.4	<2	Low-------	0.20			
Cr, Cs-----------	0-7	20-27	1.20-1.40	0.6-2.0	0.22-0.24	5.6-6.6	<2	Moderate	0.37	4	6	2-4
Crete	7-36	35-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.8	<2	High------	0.37			
	36-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High------	0.37			
Ct---------------	0-7	27-35	1.20-1.40	0.2-0.6	0.21-0.23	5.6-6.6	<2	High------	0.37	4	7	2-4
Crete	7-31	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.8	<2	High------	0.37			
	31-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High------	0.37			
Cx---------------	0-6	27-35	1.20-1.40	0.2-0.6	0.21-0.23	5.6-6.6	<2	High------	0.37	4	7	1-4
Crete	6-28	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.8	<2	High------	0.37			
	28-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High------	0.37			
Ed---------------	0-10	28-37	1.30-1.40	0.06-0.6	0.15-0.22	5.6-7.3	<2	Moderate	0.37	3	7	2-4
Edalgo	10-34	35-65	1.40-1.60	<0.06	0.10-0.18	5.6-8.4	<2	High------	0.37			
	34	---	---	---	---	---	---	----------	----			
Er---------------	0-7	5-18	1.30-1.50	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.20	5	3	1-2
Eudora	7-60	5-18	1.35-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.43			
Eu---------------	0-10	5-18	1.30-1.50	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.32	5	6	1-4
Eudora	10-60	5-18	1.35-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.43			
Gc---------------	0-10	15-27	1.30-1.40	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low-------	0.32	5	6	1-4
Geary	10-38	27-35	1.35-1.50	0.6-2.0	0.17-0.20	5.6-7.8	<2	Moderate	0.43			
	38-60	20-32	1.30-1.40	0.6-2.0	0.15-0.19	6.1-8.4	<2	Moderate	0.43			
Gf---------------	0-12	15-27	1.30-1.40	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low-------	0.32	5	6	1-4
Geary	12-42	27-35	1.35-1.50	0.6-2.0	0.17-0.20	5.6-7.8	<2	Moderate	0.43			
	42-60	20-32	1.30-1.40	0.6-2.0	0.15-0.19	6.1-8.4	<2	Moderate	0.43			
Gh---------------	0-7	27-35	1.30-1.40	0.2-0.6	0.18-0.23	5.6-6.5	<2	Moderate	0.32	5	6	1-2
Geary	7-32	27-35	1.35-1.50	0.6-2.0	0.17-0.20	5.6-7.8	<2	Moderate	0.43			
	32-60	20-32	1.30-1.40	0.6-2.0	0.15-0.19	6.1-8.4	<2	Moderate	0.43			
Gm---------------	0-24	20-25	1.40-1.60	0.6-2.0	0.21-0.23	7.4-8.4	<2	Low-------	0.32	5	4L	2-4
Gibbon	24-50	15-25	1.50-1.70	0.6-6.0	0.16-0.20	7.4-9.0	<2	Low-------	0.32			
	50-60	2-5	1.35-1.50	>6.0	0.05-0.09	7.9-8.4	<2	Low-------	0.17			
He*:												
Haynie-----------	0-6	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37	5	6	1-3
	6-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37			
Sarpy------------	0-6	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17	5	2	<1
	6-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17			
Hn, Ho-----------	0-7	15-30	1.20-1.40	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low-------	0.32	5	6	2-4
Hobbs	7-60	15-30	1.20-1.40	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low-------	0.32			
Hr---------------	0-12	15-27	1.40-1.60	0.6-2.0	0.22-0.24	5.1-7.3	<2	Low-------	0.32	5	6	1-3
Holder	12-36	28-35	1.20-1.40	0.6-2.0	0.18-0.20	5.6-7.8	<2	Moderate	0.43			
	36-60	15-30	1.40-1.60	0.6-2.0	0.20-0.22	6.6-8.4	<2	Moderate	0.43			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cm3	In/hr	In/in	pH	mmhos/cm					Pct
Ks*:												
Kipson----------	0-8	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	1-3
	8-18	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	18	---	---	---	---	---	---	---------	----			
Sogn-----------	0-12	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	1-3
	12	---	---	---	---	---	---	---------	----			
Lc-------------- Lancaster	0-9	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low-------	0.28	4	6	1-4
	9-35	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	35	---	---	---	---	---	---	---------	----			
Lh*:												
Lancaster-------	0-9	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low-------	0.28	4	6	1-4
	9-35	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	35	---	---	---	---	---	---	---------	----			
Hedville--------	0-14	8-22	1.35-1.50	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low-------	0.24	2	8	1-4
	14	---	---	---	---	---	---	---------	----			
Mu-------------- Muir	0-22	18-27	1.30-1.45	0.6-2.0	0.20-0.23	5.6-7.8	<2	Low-------	0.32	5	6	2-4
	22-60	18-35	1.30-1.50	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low-------	0.32			
Sa-------------- Sarpy	0-6	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17	5	2	<1
	6-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.17			
Su-------------- Sutphen	0-7	35-40	1.30-1.40	<0.2	0.21-0.23	6.1-8.4	<2	High------	0.37	5	7	2-4
	7-46	40-55	1.35-1.45	<0.06	0.10-0.14	6.6-8.4	<2	High------	0.28			
	46-60	35-55	1.35-1.45	<0.2	0.10-0.18	7.4-8.4	<2	High------	0.28			
Tu-------------- Tully	0-20	28-38	1.35-1.45	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7	2-4
	20-47	35-55	1.40-1.50	0.06-0.2	0.10-0.15	5.6-7.8	<2	High------	0.37			
	47-60	35-55	1.40-1.50	0.06-0.2	0.07-0.15	6.6-8.4	<2	High------	0.37			
We-------------- Wells	0-18	18-27	1.35-1.50	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low-------	0.28	5	6	1-4
	18-42	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	42-60	10-30	1.35-1.60	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low-------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Be----------------- Benfield	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High------	Low.
Cb----------------- Calco	D	Frequent----	Long------	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
Cg----------------- Cass	B	Occasional	Brief-----	Mar-Jun	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Cr, Cs, Ct, Cx---- Crete	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Ed----------------- Edalgo	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Moderate	Low.
Er----------------- Eudora	B	Rare---------	---	---	>6.0	---	---	>60	---	High------	Low-------	Low.
Eu----------------- Eudora	B	Occasional	Very brief	Mar-Jun	>6.0	---	---	>60	---	High------	Low-------	Low.
Gc, Gf, Gh--------- Geary	B	None---------	---	---	>6.0	---	---	>60	---	High------	Low-------	Low.
Gm----------------- Gibbon	B	Occasional	Very brief	Mar-Jul	1.5-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Low.
He*:												
Haynie------------	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High------	Low-------	Low.
Sarpy-------------	A	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	Low-------	Low-------	Low.
Hn----------------- Hobbs	B	Frequent----	Brief-----	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Ho----------------- Hobbs	B	Occasional	Brief-----	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Hr----------------- Holder	B	None---------	---	---	>6.0	---	---	>60	---	High------	Low-------	Low.
Ks*:												
Kipson------------	D	None---------	---	---	>6.0	---	---	7-20	Soft	Moderate	Low-------	Low.
Sogn--------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low-------	Low.
Lc----------------- Lancaster	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low-------	Moderate.
Lh*:												
Lancaster---------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low-------	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Lh*:												
Hedville	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low	Moderate.
Mu Muir	B	Rare	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
Sa Sarpy	A	Rare	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Su Sutphen	D	Occasional	Very brief	Mar-Sep	>6.0	---	---	>60	---	Low	High	Low.
Tu Tully	C	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
We Wells	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[LL means liquid limit; PI, plasticity index; MD, maximum dry density; and OM, optimum moisture. Dashes indicate that data were not available]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							LL	PI	Moisture density	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
										Pct		Lb/ft3	Pct
Eudora loam: (S82KS-027-003)													
Ap-------- 0 to 7	---	---	100	100	99	86	40	18	14	--	--	105	15
C1--------16 to 30	A-4	CL-ML	100	100	98	58	15	3	1	22	7	109	13
C2--------30 to 60	A-4	CL-ML	100	100	100	77	8	0	0	26	5	100	16
Hedville cobbly loam: (S82KS-027-004)													
A--------- 0 to 14	A-2	SC	100	98	70	33	20	10	7	35	13	111	15
Tully silty clay loam: (S82KS-027-002)													
A--------- 0 to 12	A-7	MH	100	100	100	98	65	36	29	53	22	85	26
BA--------12 to 20	A-7	CH	100	100	100	98	71	47	38	56	28	87	27
Bt2-------28 to 47	A-7	CH	100	100	100	98	74	44	35	55	30	93	26
C---------57 to 66	A-6	CL	100	100	100	98	69	28	13	47	25	95	21
Wells loam: (S82KS-027-001)													
A--------- 0 to 12	A-4	CL	100	100	99	70	36	15	10	32	10	101	19
Bt1-------18 to 28	A-6	CL	100	100	99	66	45	28	22	37	18	105	17
C---------42 to 60	A-6	CL	100	100	99	76	47	26	17	34	18	108	14

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Benfield	Fine, mixed, mesic Udic Argiustolls
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Cass	Coarse-loamy, mixed, mesic Fluventic Haplustolls
Crete	Fine, montmorillonitic, mesic Pachic Argiustolls
Edalgo	Fine, mixed, mesic Udic Argiustolls
Eudora	Coarse-silty, mixed, mesic Fluventic Hapludolls
Geary	Fine-silty, mixed, mesic Udic Argiustolls
Gibbon	Fine-silty, mixed (calcareous), mesic Fluvaquentic Haplaquolls
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
Hedville	Loamy, mixed, mesic Lithic Haplustolls
Hobbs	Fine-silty, mixed, nonacid, mesic Mollic Ustifluvents
Holder	Fine-silty, mixed, mesic Udic Argiustolls
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Lancaster	Fine-loamy, mixed, mesic Udic Argiustolls
Muir	Fine-silty, mixed, mesic Cumulic Haplustolls
Sarpy	Mixed, mesic Typic Udipsamments
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Sutphen	Fine, montmorillonitic, mesic Udertic Haplustolls
Tully	Fine, mixed, mesic Pachic Argiustolls
Wells	Fine-loamy, mixed, mesic Udic Argiustolls

INTERPRETIVE GROUPS

Soil name and map symbol	Land capability* N	Land capability* I	Prime farmland*	Range site
Be: Benfield	IVe	---	No	Loamy Upland.
Cb: Calco	Vw	---	No	Subirrigated.
Cg: Cass	IIw	IIw	Yes	Sandy Lowland.
Cr: Crete	IIs	---	Yes	Clay Upland.
Cs: Crete	IIe	---	Yes	Clay Upland.
Ct: Crete	IIIe	---	Yes	Clay Upland.
Cx: Crete	IVe	---	No	Clay Upland.
Ed: Edalgo	IVe	---	No	Clay Upland.
Er: Eudora	IIe	IIe	Yes	Loamy Terrace.
Eu: Eudora	IIw	IIw	Yes	Loamy Lowland.
Gc: Geary	IIIe	---	Yes	Loamy Upland.
Gf: Geary	VIe	---	No	Loamy Upland.
Gh: Geary	IVe	---	No	Loamy Upland.
Gm: Gibbon	IIw	IIw	Yes**	Subirrigated.
He:	VIw	---	No	
Haynie				Loamy Lowland.
Sarpy				Sandy Lowland.
Hn: Hobbs	Vw	---	No	Loamy Lowland.
Ho: Hobbs	IIw	IIw	Yes	Loamy Lowland.
Hr: Holder	IIIe	---	Yes	Loamy Upland.
Ks:	VIe	---	No	
Kipson				Limy Upland.
Sogn				Shallow Limy.
Lc: Lancaster	IVe	---	Yes	Loamy Upland.
Lh:	VIe	---	No	
Lancaster				Loamy Upland.
Hedville				Shallow Sandstone.

See footnotes at end of table.

Soil name and map symbol	Land capability* N	Land capability* I	Prime farmland*	Range site
Mu---------------------------- Muir	I	I	Yes	Loamy Terrace
Sa---------------------------- Sarpy	IVs	---	No	Sandy Lowland.
Su---------------------------- Sutphen	IIw	IIw	Yes	Clay Lowland.
Tu---------------------------- Tully	IIIe	---	Yes	Loamy Upland.
We---------------------------- Wells	IIIe	---	Yes	Loamy Upland.

* A soil complex is treated as a single management unit in the land capability classification and prime farmland columns. The N column is for nonirrigated soils; the I column is for irrigated soils.

** Where drained.

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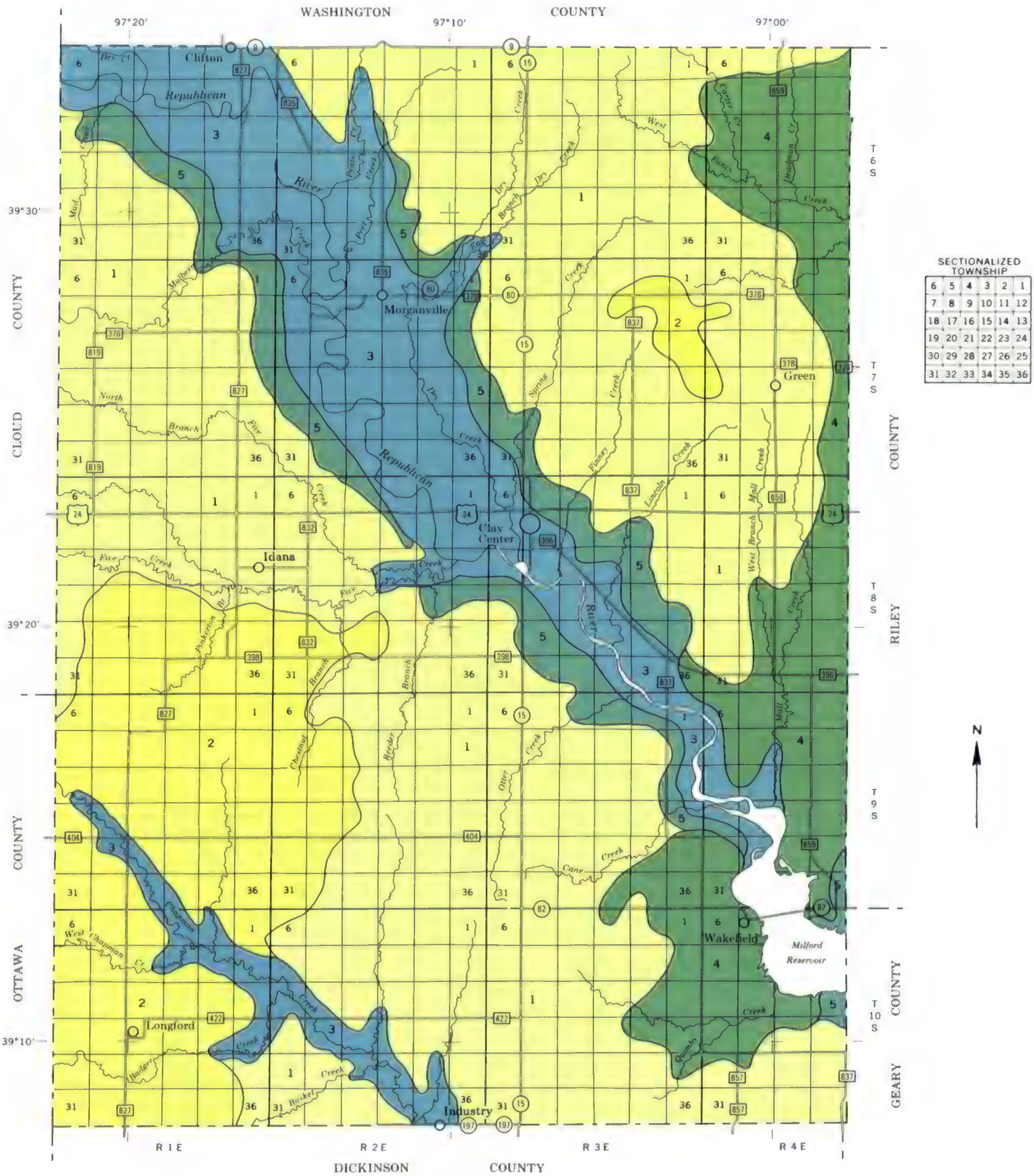


LEGEND

- 1 — CRETE-HOBBS association: Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a clayey or silty subsoil; on uplands and flood plains
- 2 — CRETE-LANCASTER-HEDVILLE association: Deep to shallow, moderately sloping to steep, moderately well drained to somewhat excessively drained soils that have a clayey or loamy subsoil; on uplands
- 3 — MUIR-EUDORA association: Deep, nearly level to moderately sloping, well drained soils that have a silty or loamy subsoil; on terraces and flood plains
- 4 — CRETE-KIPSON-SOGN association: Deep and shallow, nearly level to moderately steep, moderately well drained and somewhat excessively drained soils that have a clayey or silty subsoil; on uplands
- 5 — GEARY-HOLDER association: Deep, moderately sloping and strongly sloping, well drained soils that have a silty subsoil; on uplands

Compiled 1984

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

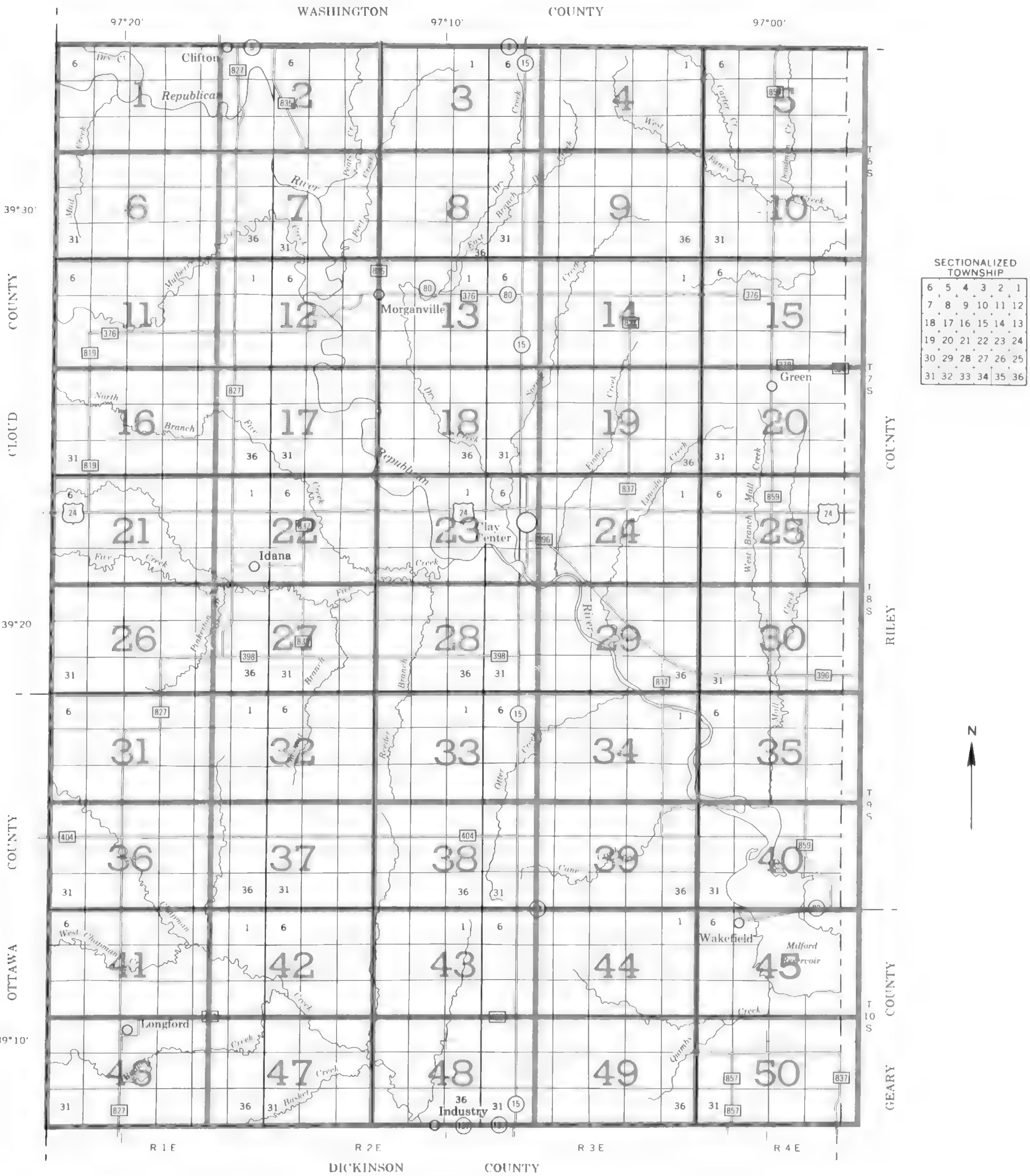
CLAY COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:
This map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS
CLAY COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

SOIL LEGEND

SYMBOL	NAME
Be	Benfield silty clay loam, 3 to 7 percent slopes
Cb	Calco silty clay loam, frequently flooded
Cg	Cass fine sandy loam, occasionally flooded
Cr	Crete silt loam, 0 to 1 percent slopes
Cs	Crete silt loam, 1 to 3 percent slopes
Ct	Crete silty clay loam, 3 to 7 percent slopes
Cx	Crete silty clay loam, 3 to 8 percent slopes, eroded
Ed	Edalgo silty clay loam, 4 to 8 percent slopes
Er	Eudora very fine sandy loam, 2 to 5 percent slopes
Eu	Eudora loam, occasionally flooded
Gc	Geary silt loam, 2 to 7 percent slopes
Gt	Geary silt loam, 9 to 15 percent slopes
Gh	Geary silty clay loam, 4 to 9 percent slopes, eroded
Gm	Gibbon loam, occasionally flooded
He	Haynie-Sarpy complex, occasionally flooded
Hn	Hobbs silt loam, channeled
Ho	Hobbs silt loam, occasionally flooded
Hr	Holder silt loam, 3 to 7 percent slopes
Ks	Kipson-Sogn silty clay loams, 5 to 20 percent slopes
Lc	Lancaster loam, 3 to 7 percent slopes
Lh	Lancaster-Hedville complex, 5 to 30 percent slopes
Mu	Muir silt loam
Sa	Sarpy loamy fine sand, undulating
Su	Sutphen silty clay loam, occasionally flooded
Tu	Tully silty clay loam, 2 to 7 percent slopes
We	Wells loam, 3 to 7 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

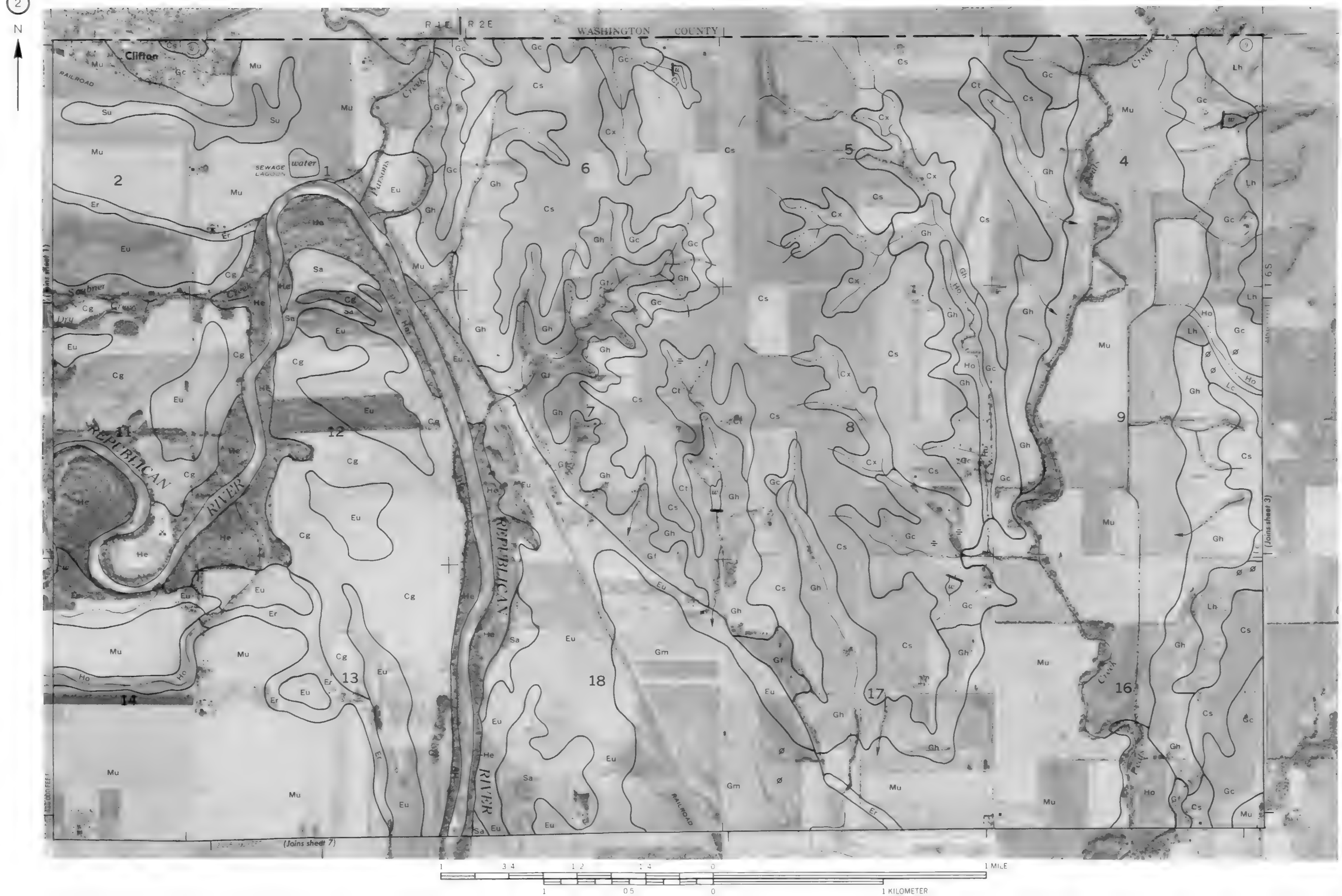
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Borrow areas


1
N
WASHINGTON COUNTY
R. 1 E.
CLOUD COUNTY
REPUBLICAN RIVER
REPUBLICAN RIVER
Dry Creek
Dry Creek
Mud Creek
Clifton
(Joins sheet 2)
(Joins sheet 6)
1 MILE
1 KILOMETER


2
N
R 1 E
R 2 E
WASHINGTON COUNTY
Clifton
RAILROAD
SEWAGE LAGOON
water
Parsons Creek
Seabner Creek
Dry Creek
REPUBLICAN RIVER
REPUBLICAN RIVER
RAILROAD
Mill Creek
T 6 S
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 7)
1 MILE
1 KILOMETER
0.5

3

N

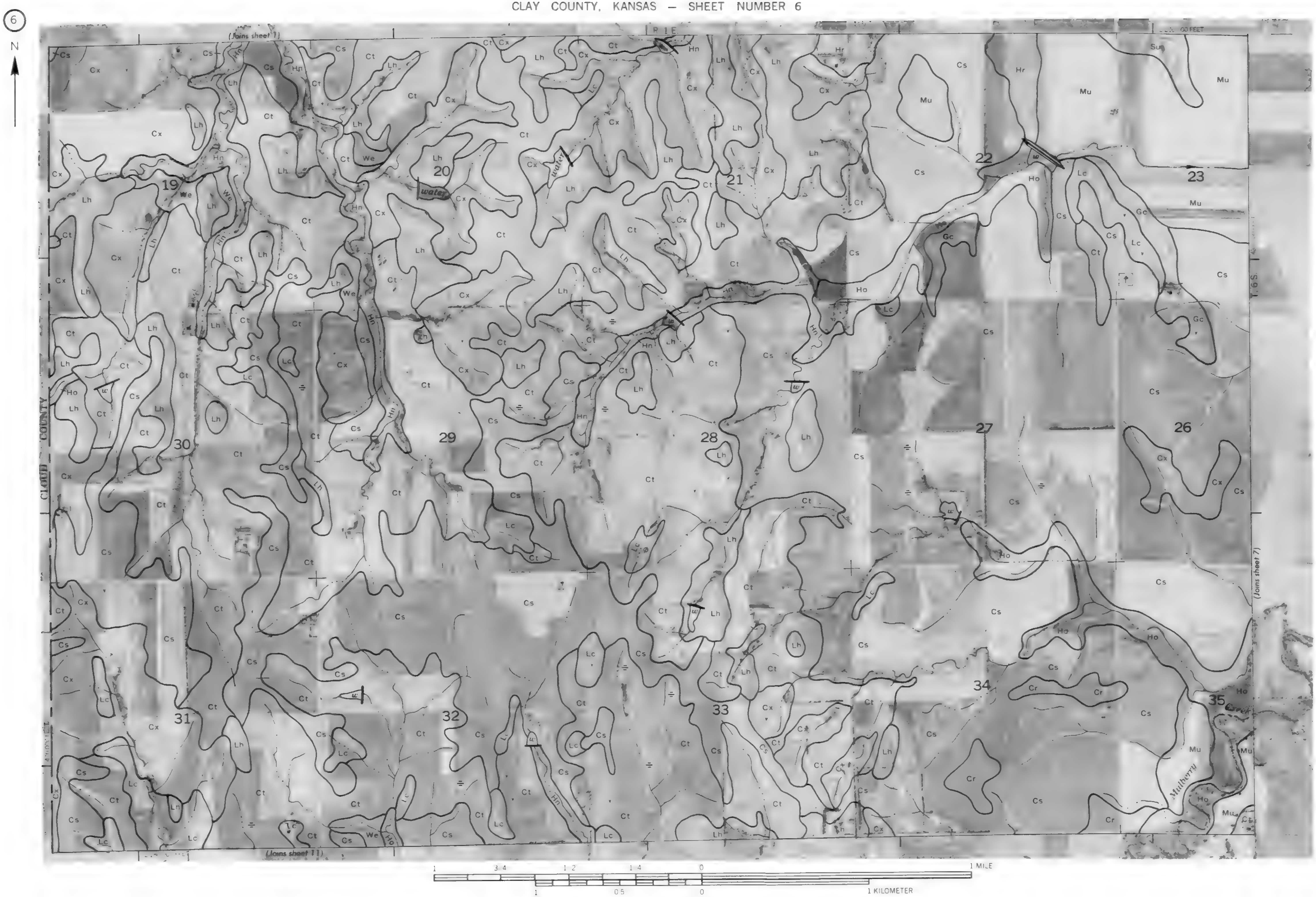

WASHINGTON COUNTY
R 2 E
R 3 E
T. 6 S.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 6)
Dry Creek
Walter
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER

CLAY COUNTY, KANSAS — SHEET NUMBER 4

4

N

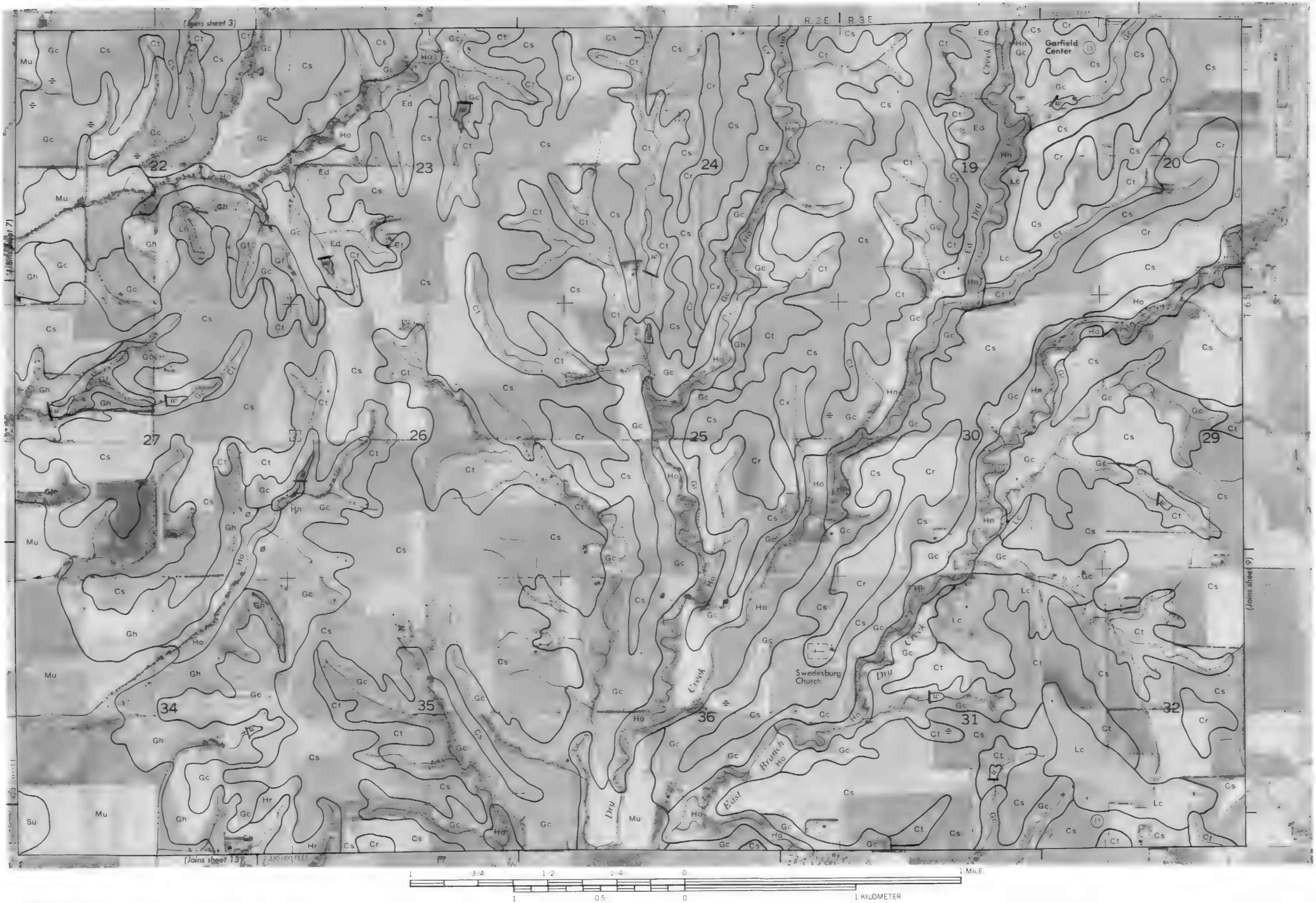

5
N
WASHINGTON COUNTY
R. 4 E.
RILEY COUNTY
T. 6 S.
(Joins sheet 4)
(Joins sheet 10)
Deadman Creek
Carter Creek
Fact Church
Fact
1 MILE
1 KILOMETER


6
N
(Joins sheet 1)
(Joins sheet 7)
(Joins sheet 11)
CLOUD COUNTY
R 1 E
6 S.
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
Mulberry
Creek
1 MILE
1 KILOMETER

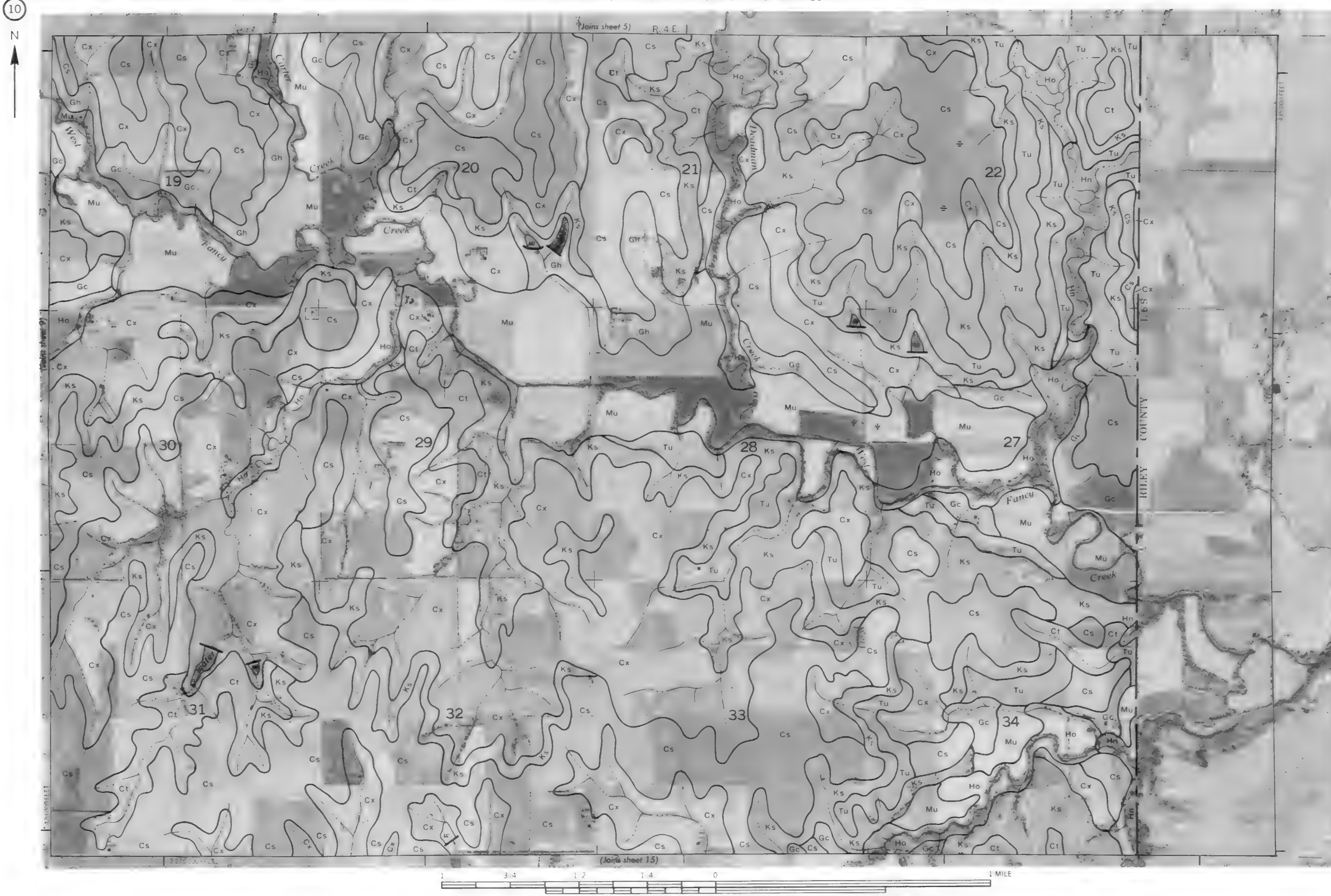

7
N
R 1 E
R 2 E
2 205 000 FEET
T. 6 S.
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 12)
(Joins sheet 6)
REPUBLICAN
RIVER
REPUBLICAN
RIVER
Peats Creek
Mulberry Creek
Mulberry
RAILROAD
RAILROAD
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Mu
Eu
Sa
Gm
Cg
Cs
Gc
Gh
Ho
He
Er
Su
Ct
1 MILE
1 KILOMETER

8

N

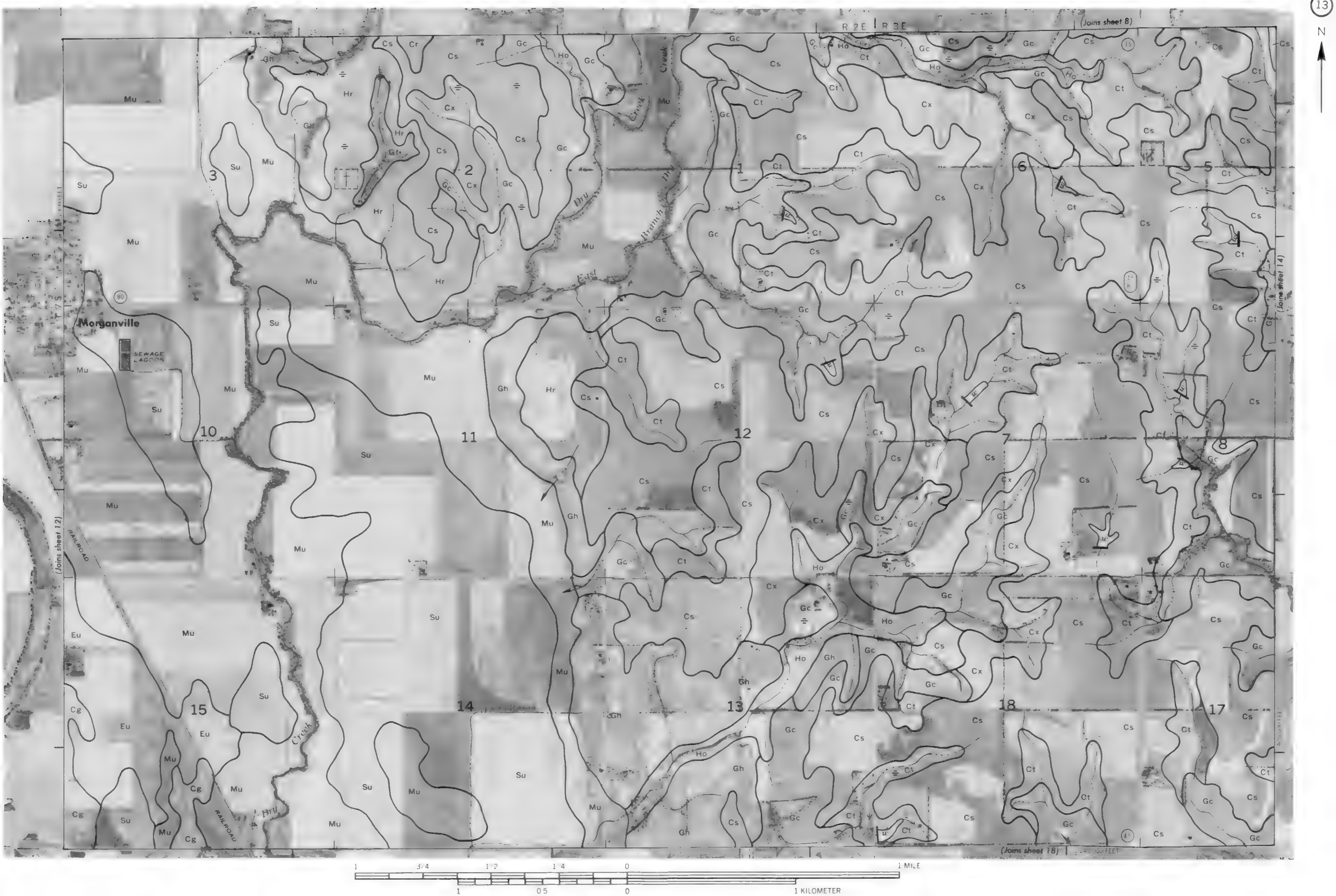

(Joins sheet 3)
R.2 E
R.3 E
Garfield Center
Swedesburg Church
Dry Creek
East Branch
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 13)
T. 6 S.
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 MILE
1 KILOMETER
0.5
0

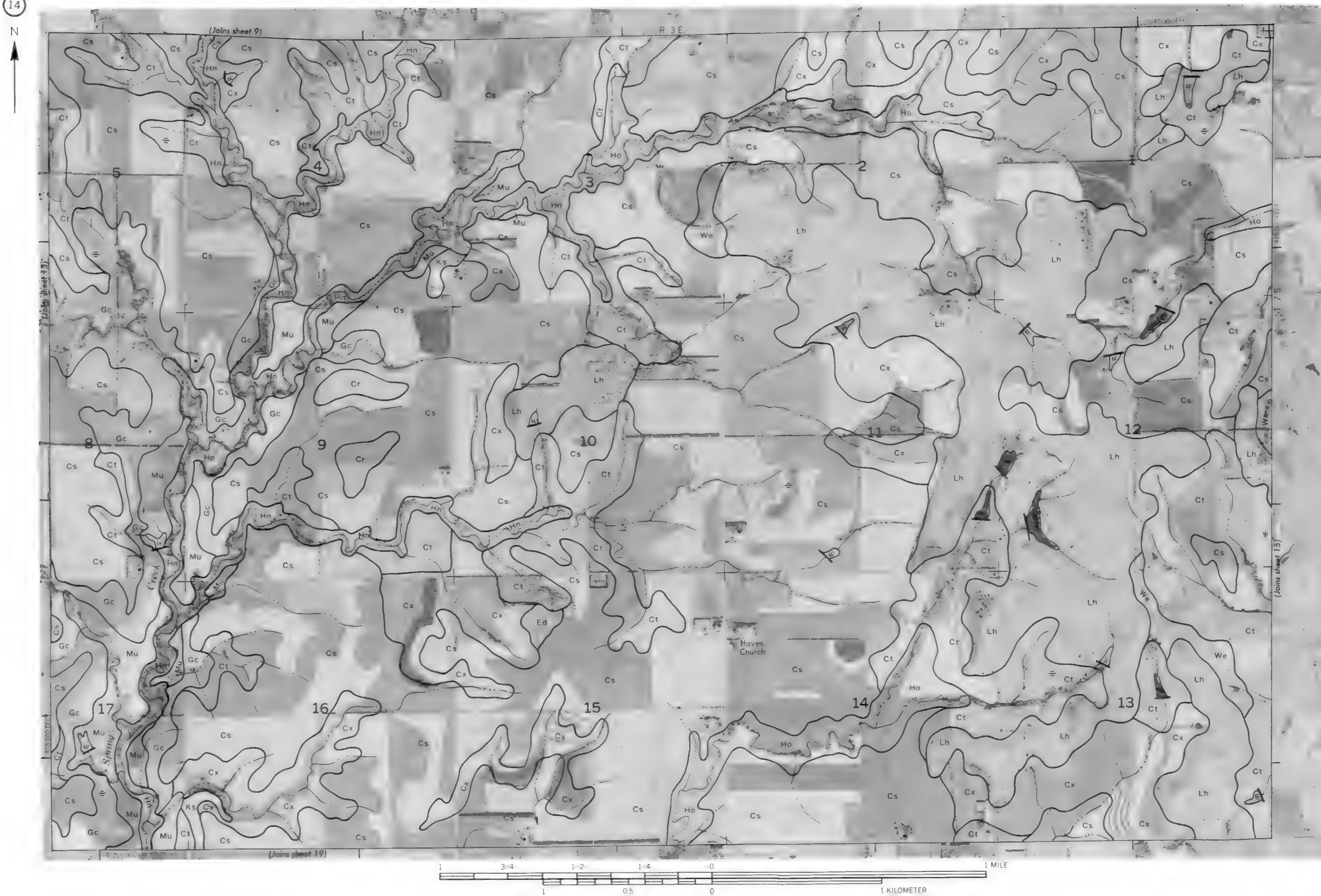

9
N
R 3 E
(Joins sheet 4)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
T. 6 S.
West Fancy Creek
Creek
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
Cs
Ct
Cx
Hn
Lh
Be
Ks
Gc
Gh
Ho
Mu
1
3/4
1/2
1/4
0
1 MILE
1
0.5
0
1 KILOMETER

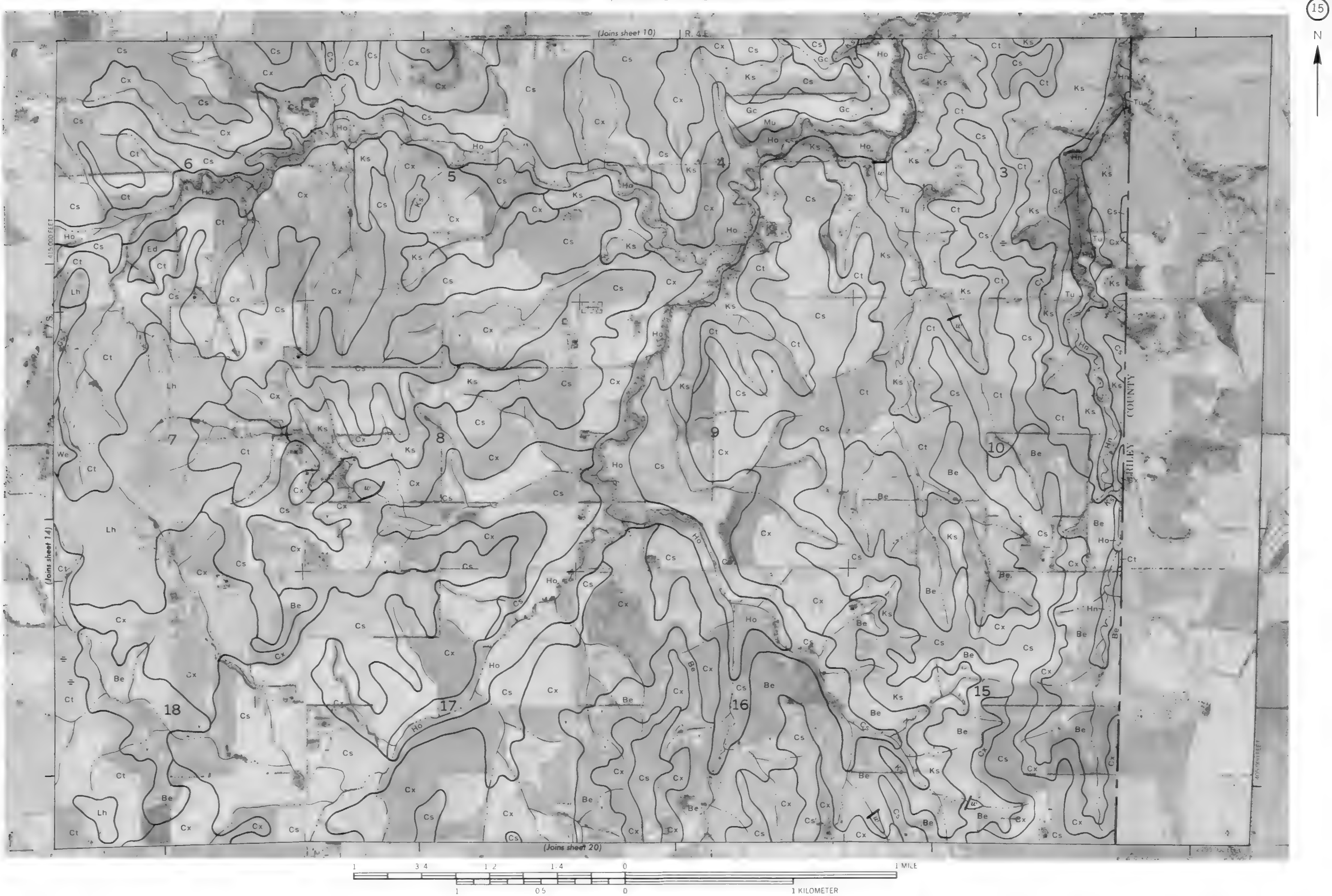

10
N
(Joins sheet 5)
R. 4 E.
(Joins sheet 15)
RILEY COUNTY
West
Carter
Creek
Fancy
Creek
Deadman
Creek
Fancy
Creek
Water
19
20
21
22
27
28
29
30
31
32
33
34
1 MILE
1 KILOMETER

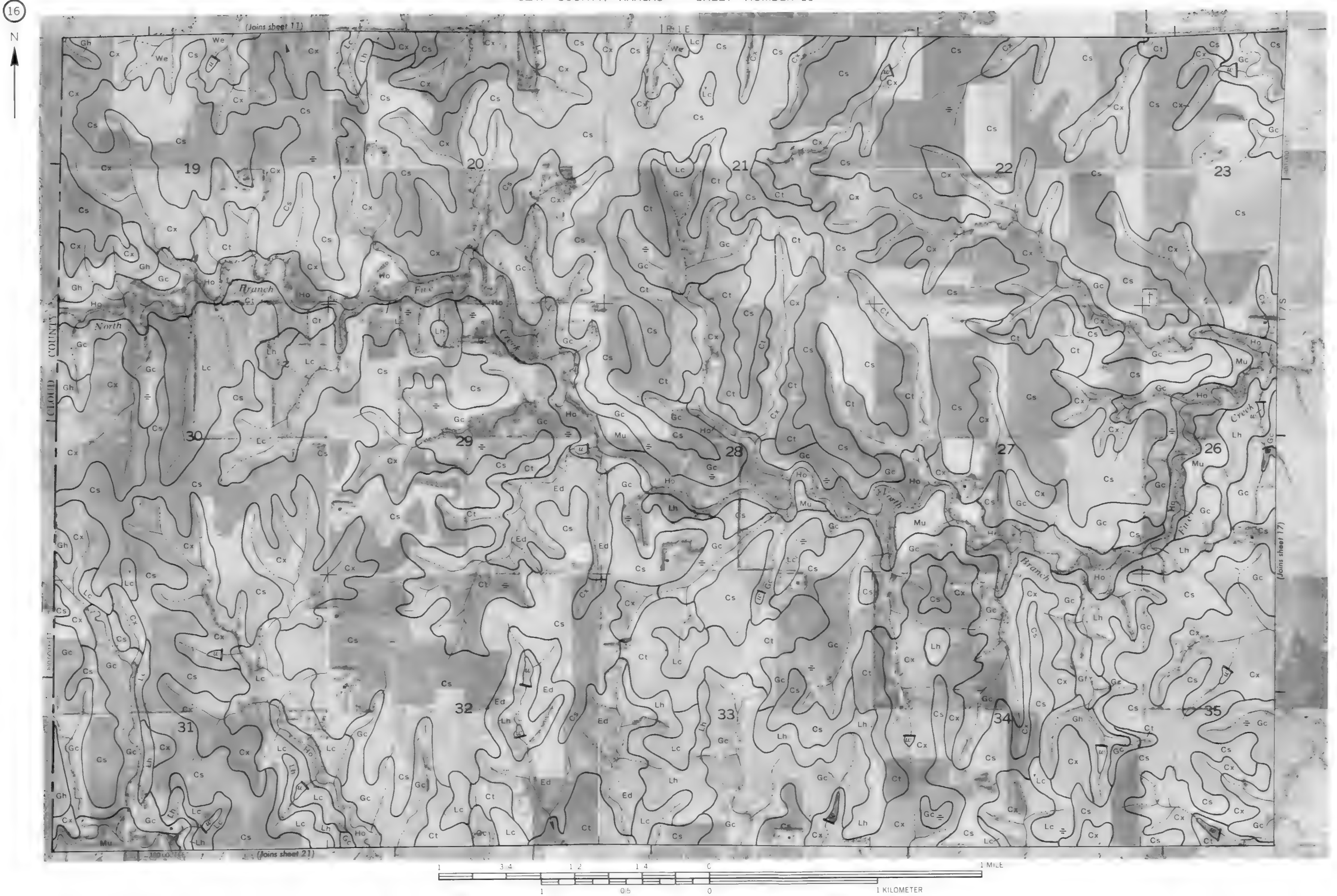

N
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 16)
CLOUD COUNTY
R 1 E
Mulberry
Creek
Mulberry
Creek
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER

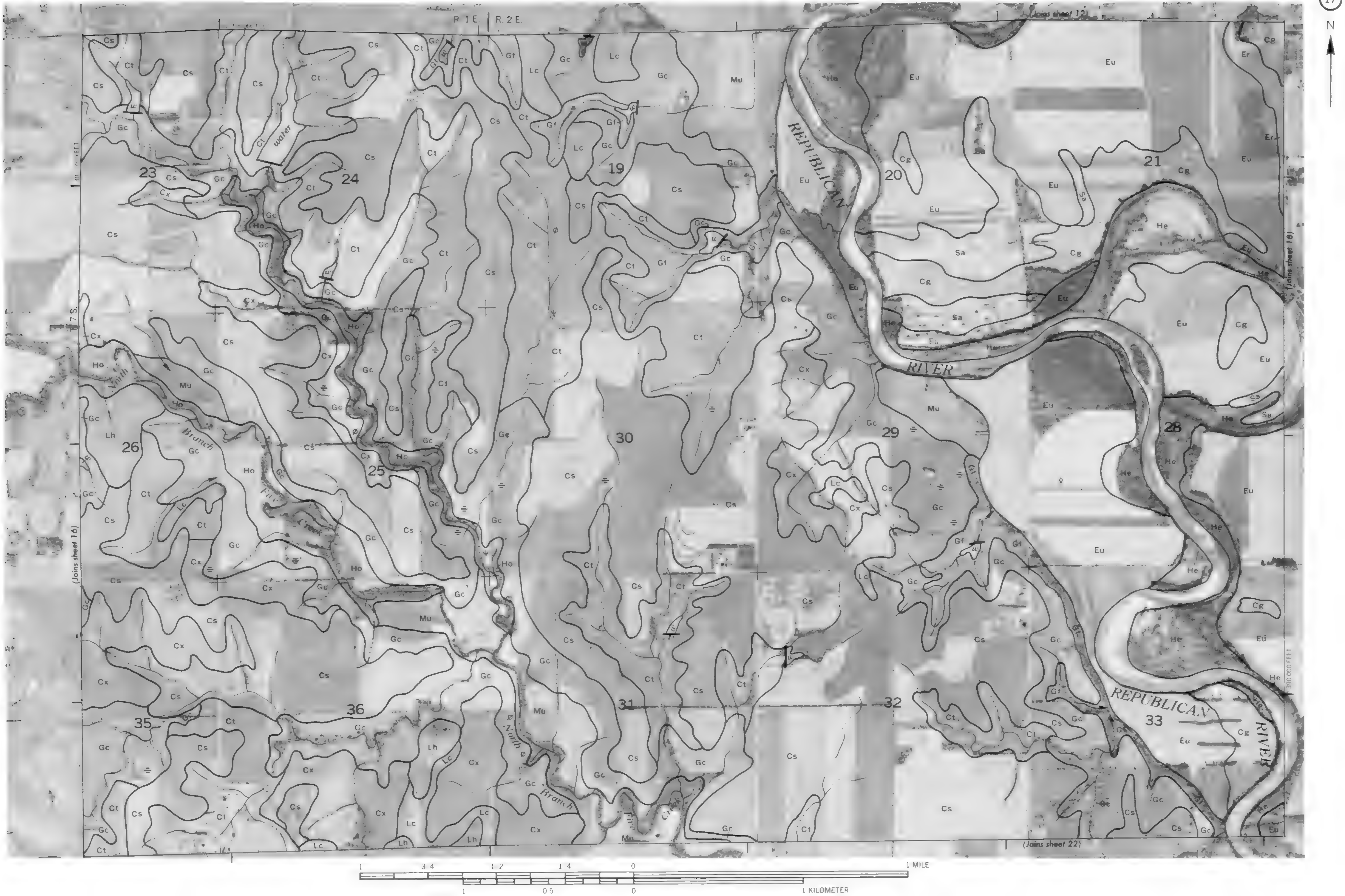

12
N
R.1 E
R.2 E
(Joins sheet 7)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 17)
Mulberry Creek
REPUBLICAN RIVER
RAILROAD
Morganville
1 MILE
1 KILOMETER


13
N
R 2 E
R 3 E
(Joins sheet 8)
(Joins sheet 14)
(Joins sheet 18)
(Joins sheet 12)
Morganville
SEWAGE LAGOON
80
15
East
Dry
Branch
Creek
Dry
Creek
RAILROAD
RAILROAD
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
Cs
Cx
Ct
Cr
Cg
Gc
Gh
Gf
Ho
Hr
Mu
Su
Eu
1
3/4
1/2
1/4
0
1 MILE
1
0.5
0
1 KILOMETER


14
N
(Joins sheet 9)
R 3 E.
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 19)
T 7 S
Hayes Church
Spring Creek
1 MILE
1 KILOMETER


15
N
(Joins sheet 10)
R. 4 E.
(Joins sheet 14)
(Joins sheet 20)
RILEY COUNTY
415 000 FEET
1 MILE
1 KILOMETER

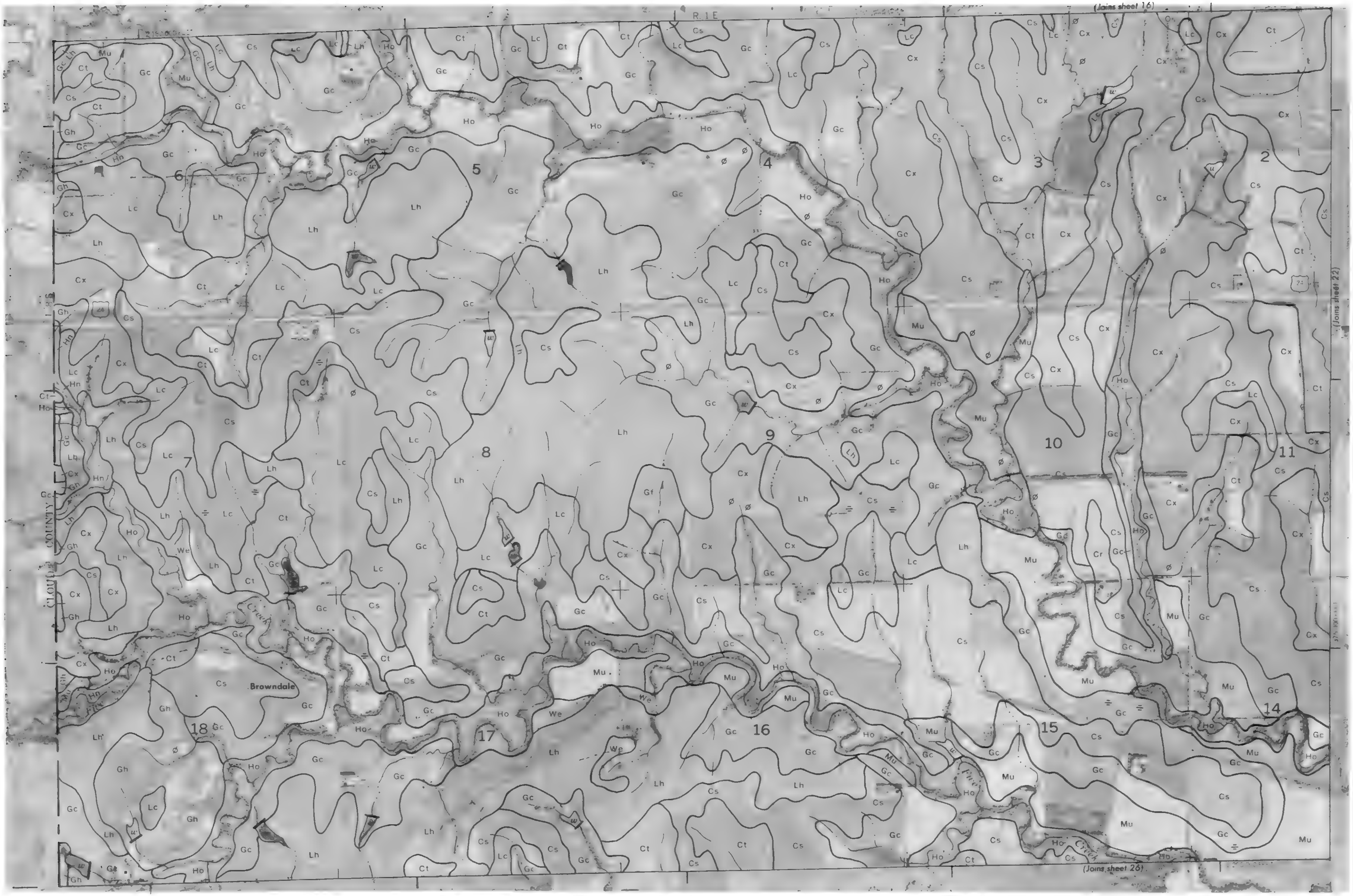

16
N
(Joins sheet 11)
(Joins sheet 17)
(Joins sheet 21)
CLOUD COUNTY
North Branch Five Creek
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER


17
N
R.1E. | R.2E.
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 16)
(Joins sheet 22)
7 S.
REPUBLICAN RIVER
REPUBLICAN RIVER
North Branch Fancy Creek
North Branch Fancy Creek
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
390 000 FEET
1 MILE
1 KILOMETER
1 3/4 1/2 1/4 0
1 0.5 0


18
N
(Joins sheet 13)
(Joins sheet 23)
(Joins sheet 19)
R 2 E
R 3 E
RAILROAD
Dry Creek
Spring Creek
water
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 MILE
1 KILOMETER

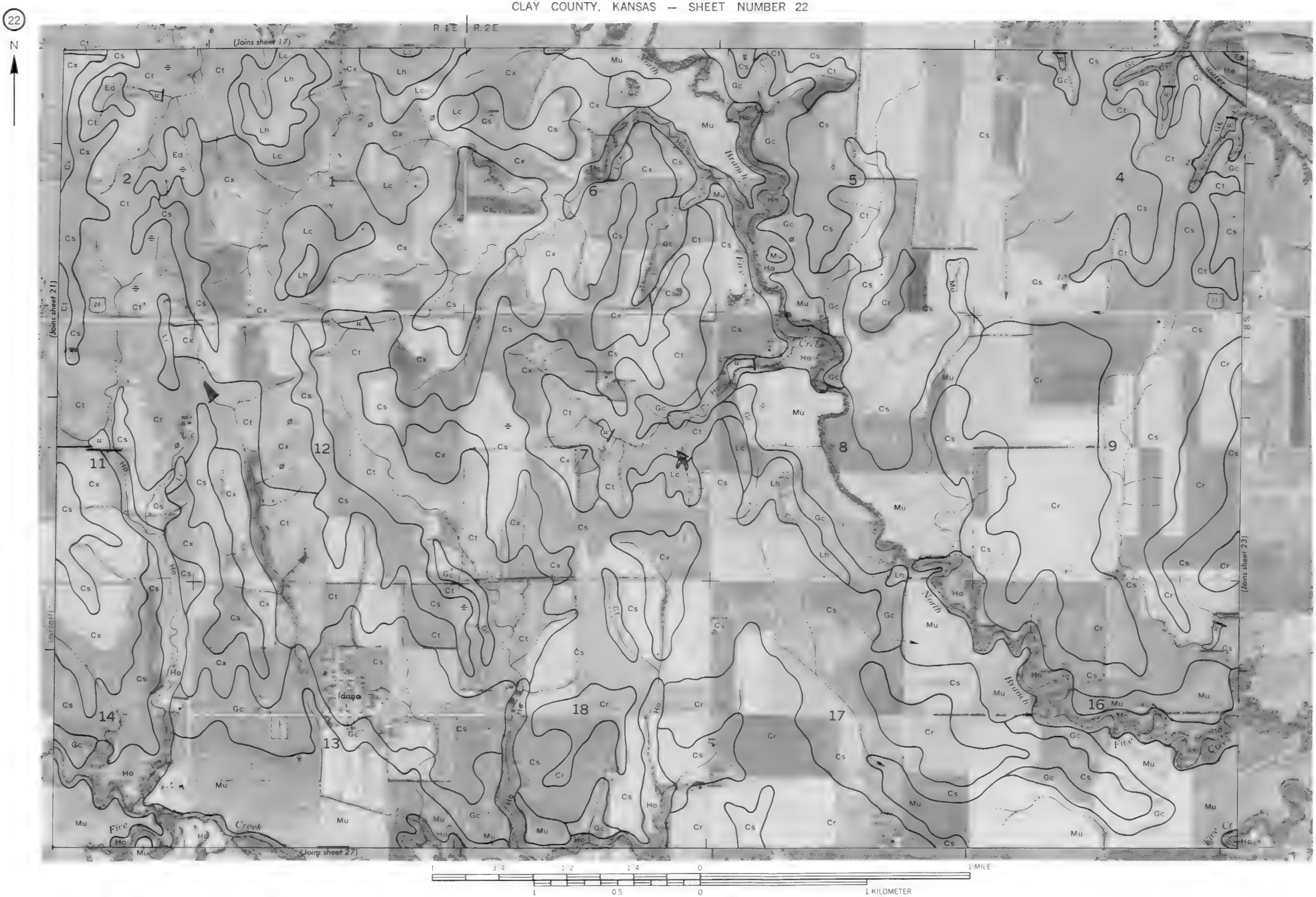

19
N
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 24)
(Joins sheet 18)
R. 3 E.
T. 7 S.
Spring
Creek
Finney
Creek
Lincoln
Creek
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
1 MILE
1 KILOMETER

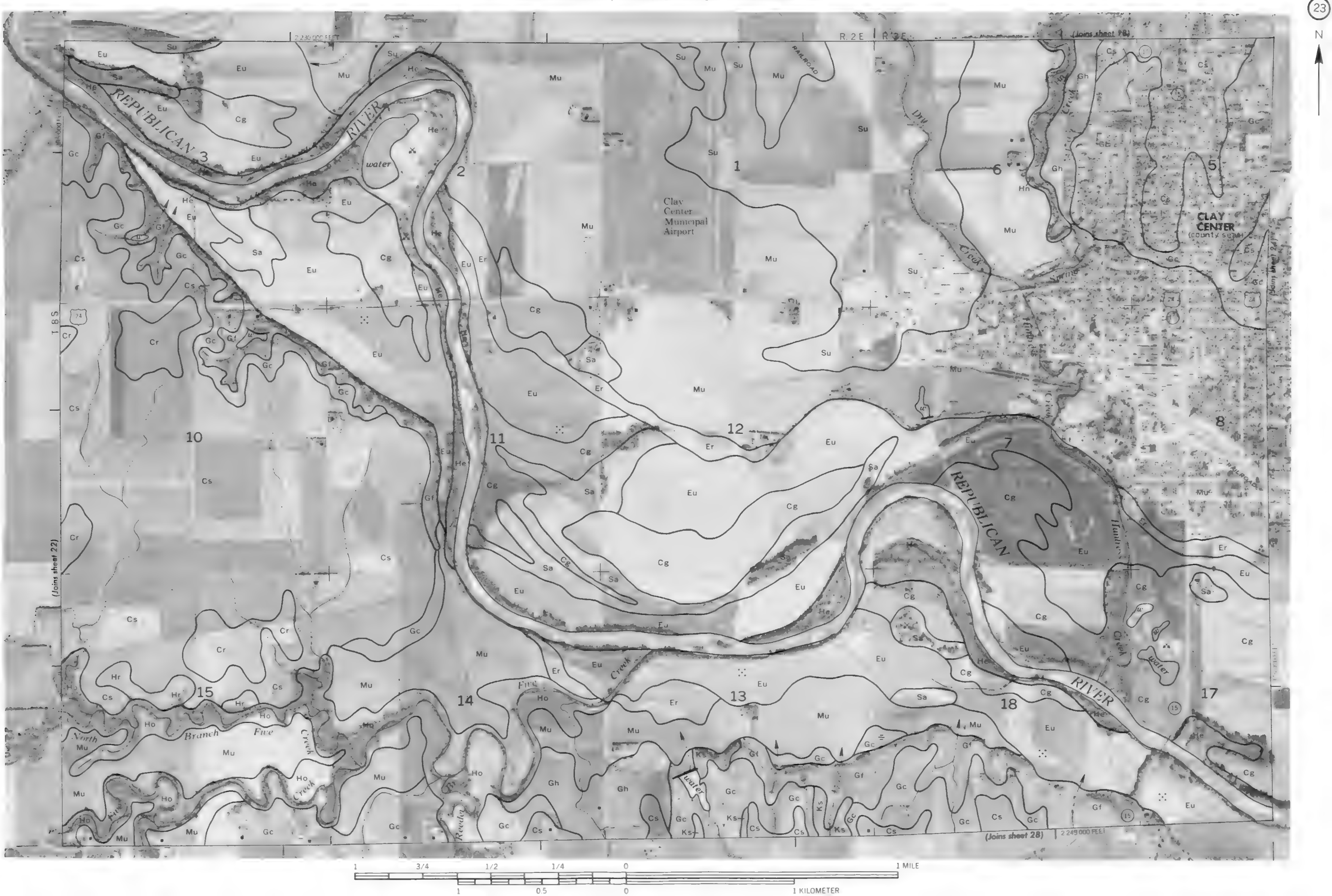

20
N
(Joins sheet 15)
R 4 E
(Joins sheet 19)
(Joins sheet 25)
Green
RILEY COUNTY
19
20
21
22
27
28
29
30
31
32
33
34
Mall Creek
West Branch
water
1 MILE
1 KILOMETER



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER


22
N
R. 1 E. | R. 2 E.
(Joins sheet 17)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 27)
T. 8 S.
North Branch Fire Creek
North Branch
Fire Creek
Idana
24
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18
1 MILE
1 KILOMETER

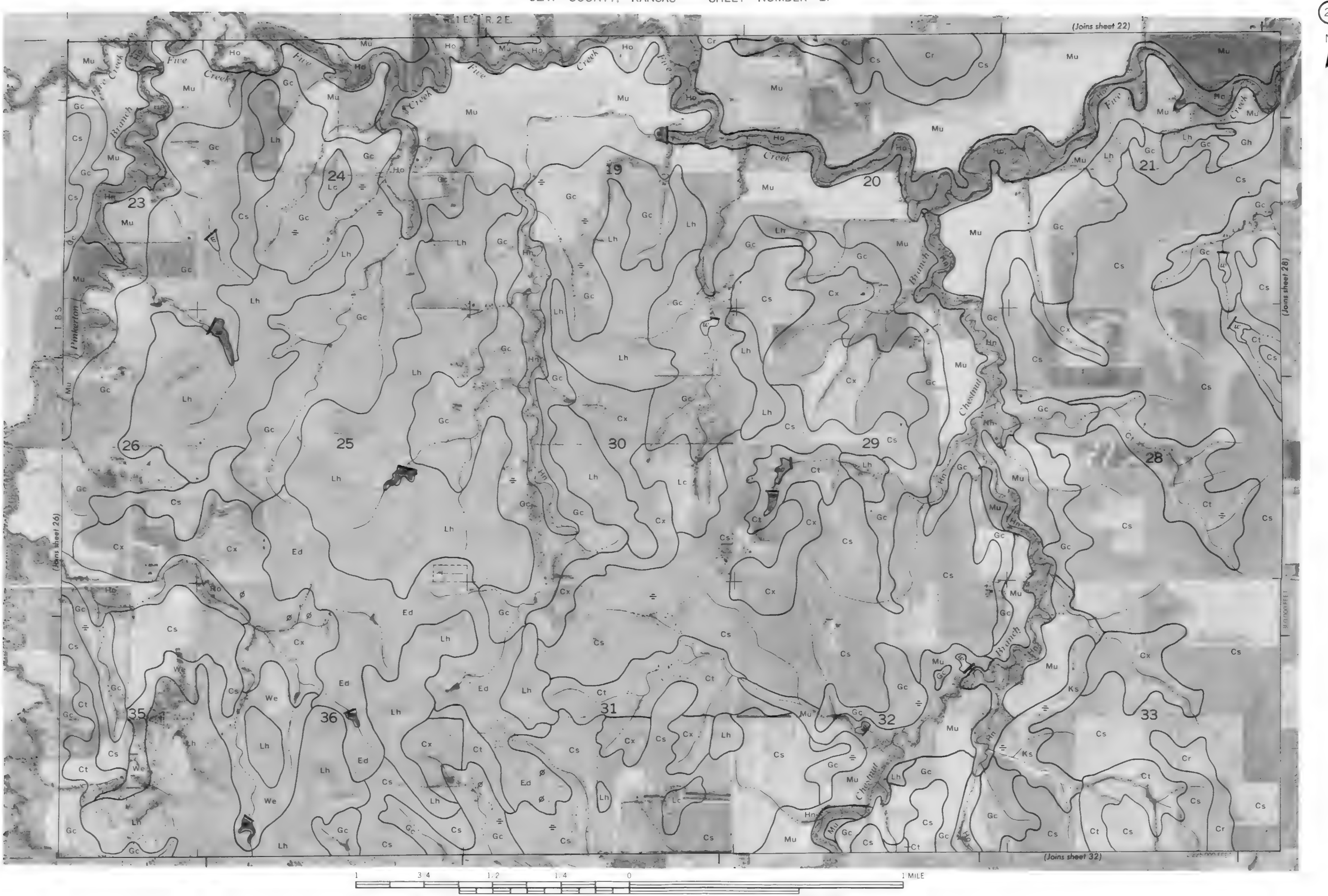

23
N
R.2 E
R.3 E
2 230 000 FEET
(Joins sheet 18)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 28)
2 249 000 FEET
T 8 S
REPUBLICAN RIVER
REPUBLICAN RIVER
Clay Center Municipal Airport
CLAY CENTER (county seat)
RAILROAD
Dry Creek
Spring Creek
Huntress Creek
Five Creek
North Branch Five Creek
Reeder Br
water
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER

CLAY COUNTY, KANSAS — SHEET NUMBER 24

N

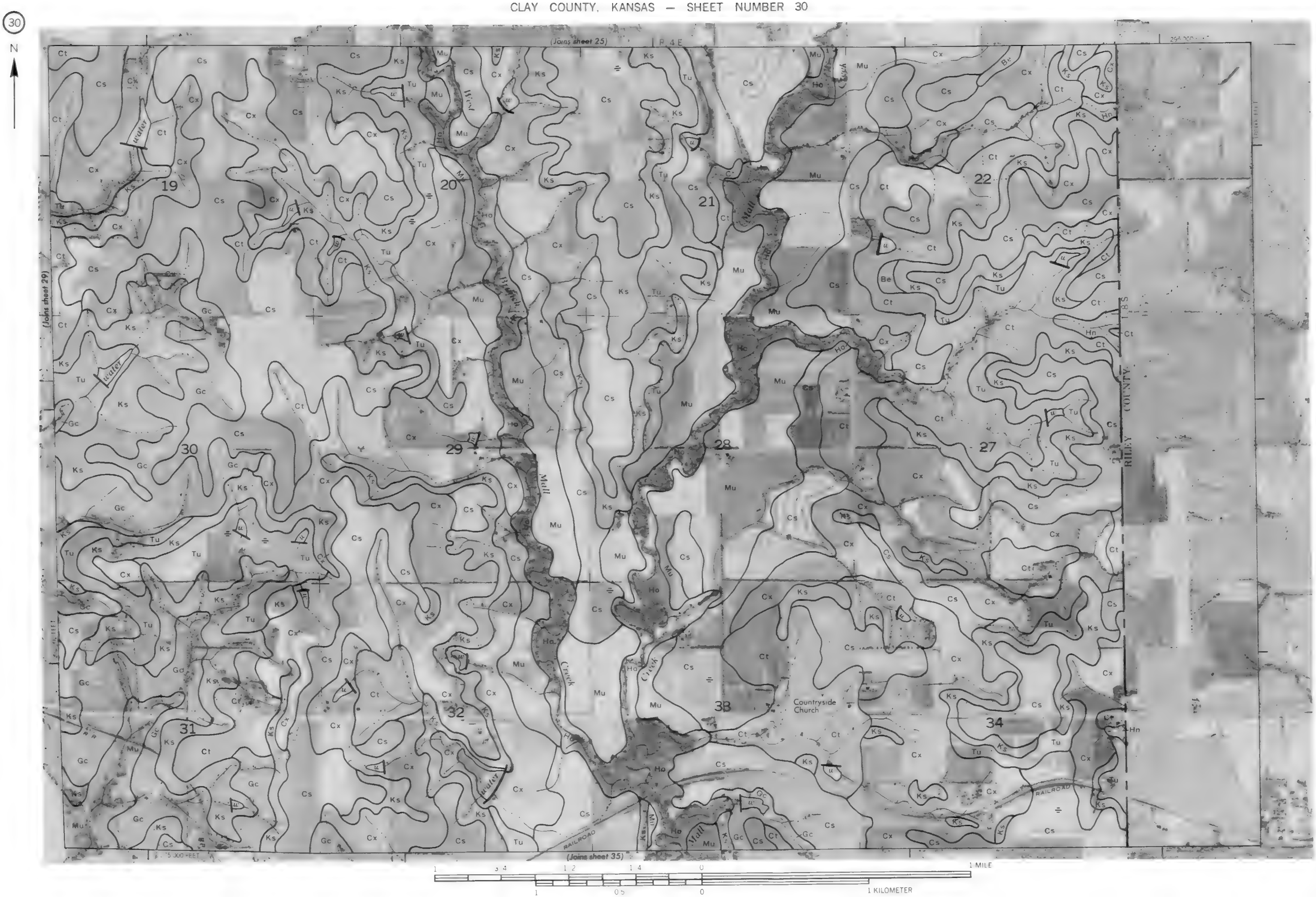

25
N
(Joins sheet 20)
R 4 E
(Joins sheet 24)
(Joins sheet 30)
RILEY COUNTY
Ebenezer Church
West Branch
Mall Creek
water
1 MILE
1 KILOMETER

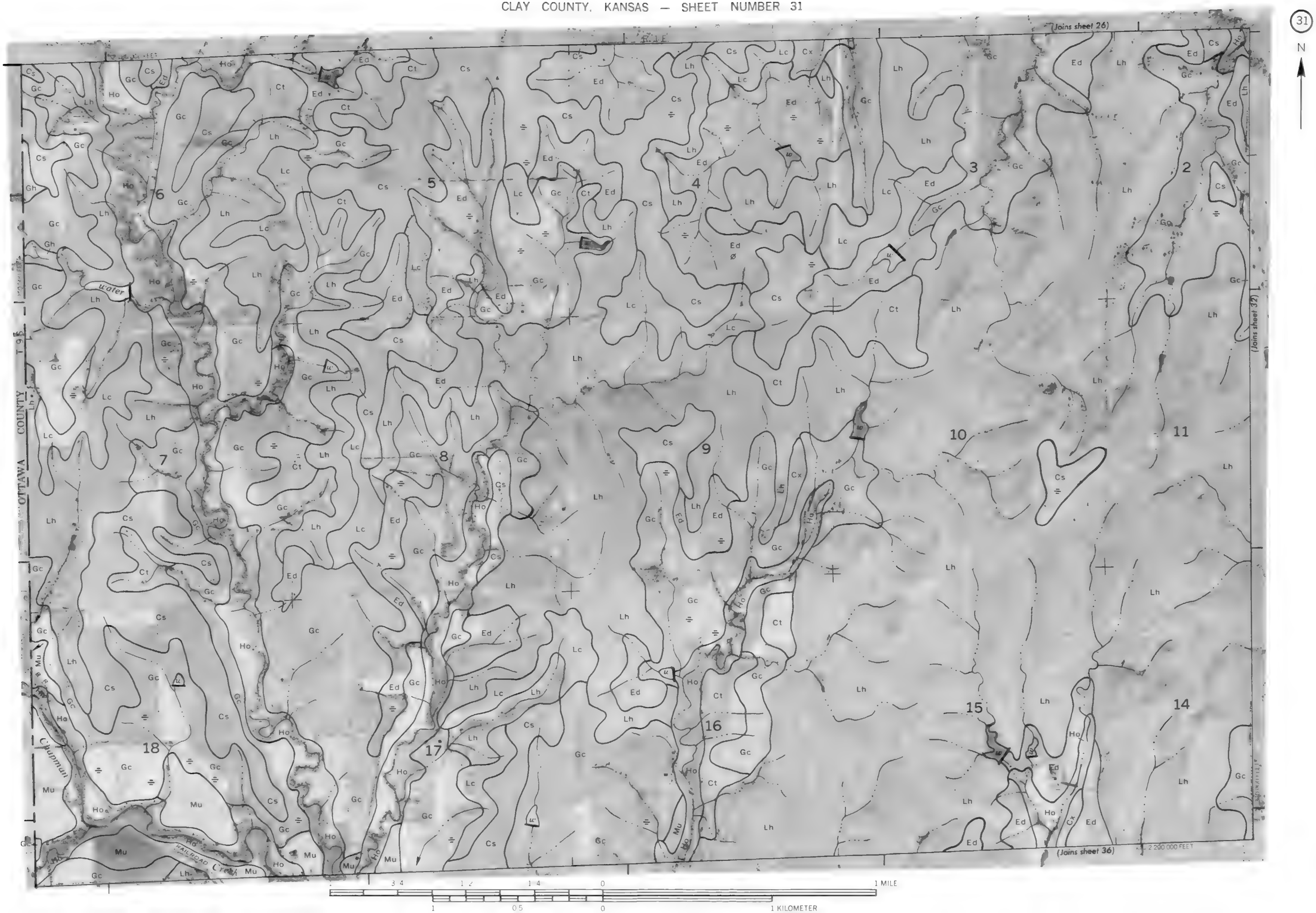
CLAY COUNTY, KANSAS — SHEET NUMBER 26

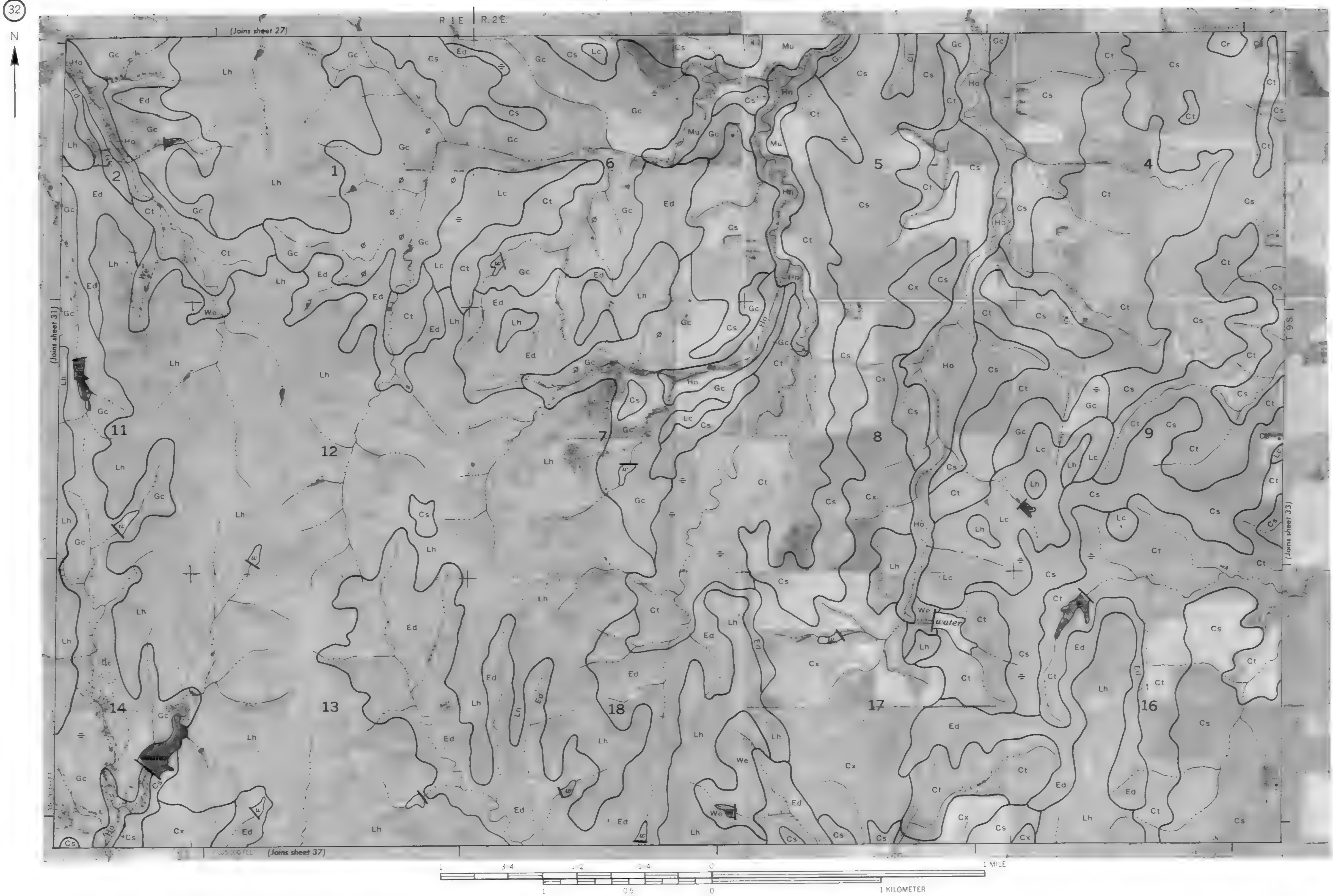

27
N
R. 1 E.
R. 2 E.
T. 8 S.
(Joins sheet 22)
(Joins sheet 28)
(Joins sheet 32)
(Joins sheet 26)
Five Creek
Pinkerton Branch
Chestnut Branch
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Mu
Ho
Gc
Cs
Lh
Lc
Hn
Cx
Cr
Ct
Gh
Ed
We
Ks
1 MILE
1 KILOMETER

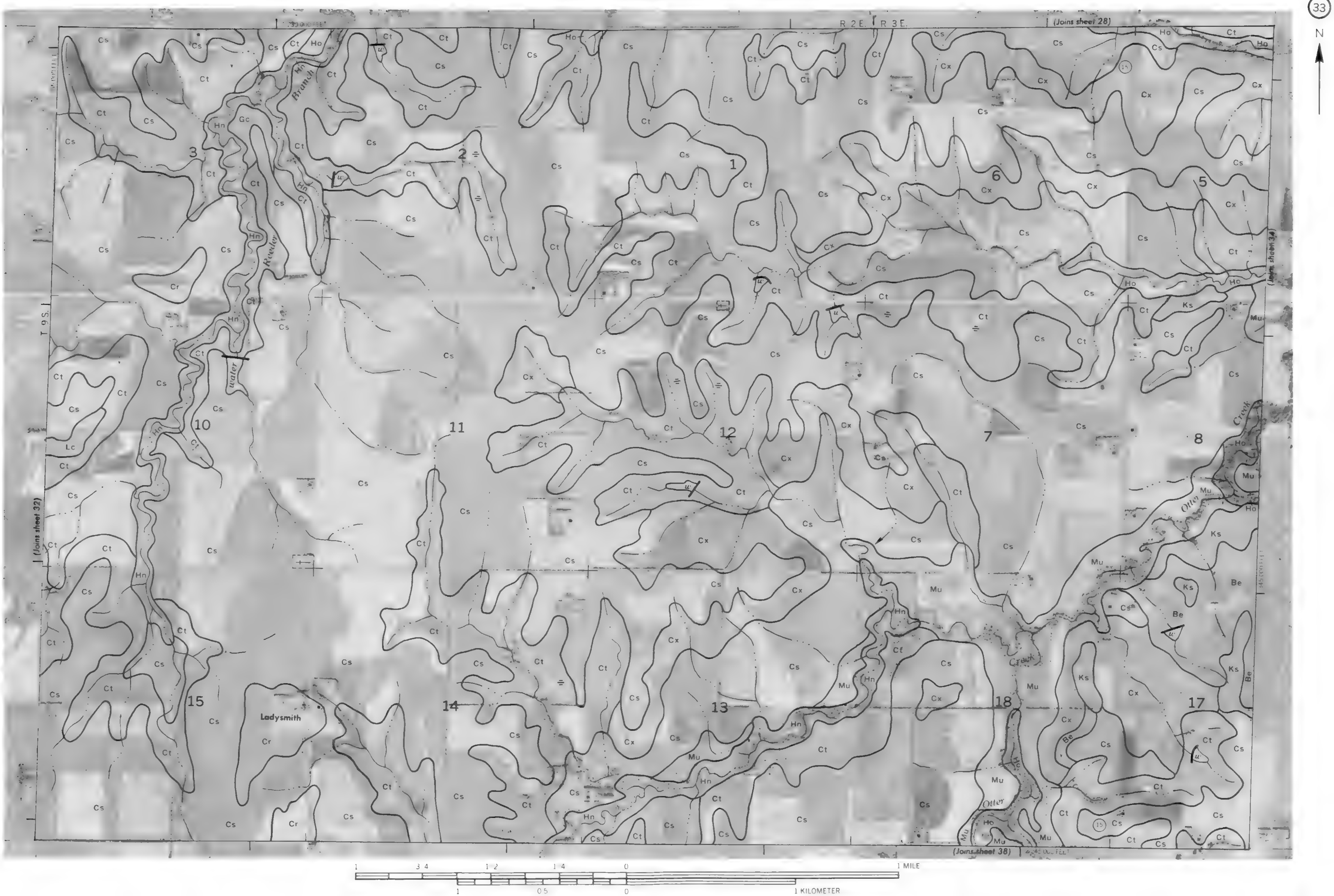

28
N
(Joins sheet 23)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 33)
R 2 E.
R 3 E.
T 8 S.
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
water
Reeder
Branch
1 MILE
1 KILOMETER

29
N
R. 3 E.
T 8 S
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 28)
(Joins sheet 34)
REPUBLICAN RIVER
REPUBLICAN
RIVER
Lincoln
Creek
Otter
Creek
RAILROAD
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER

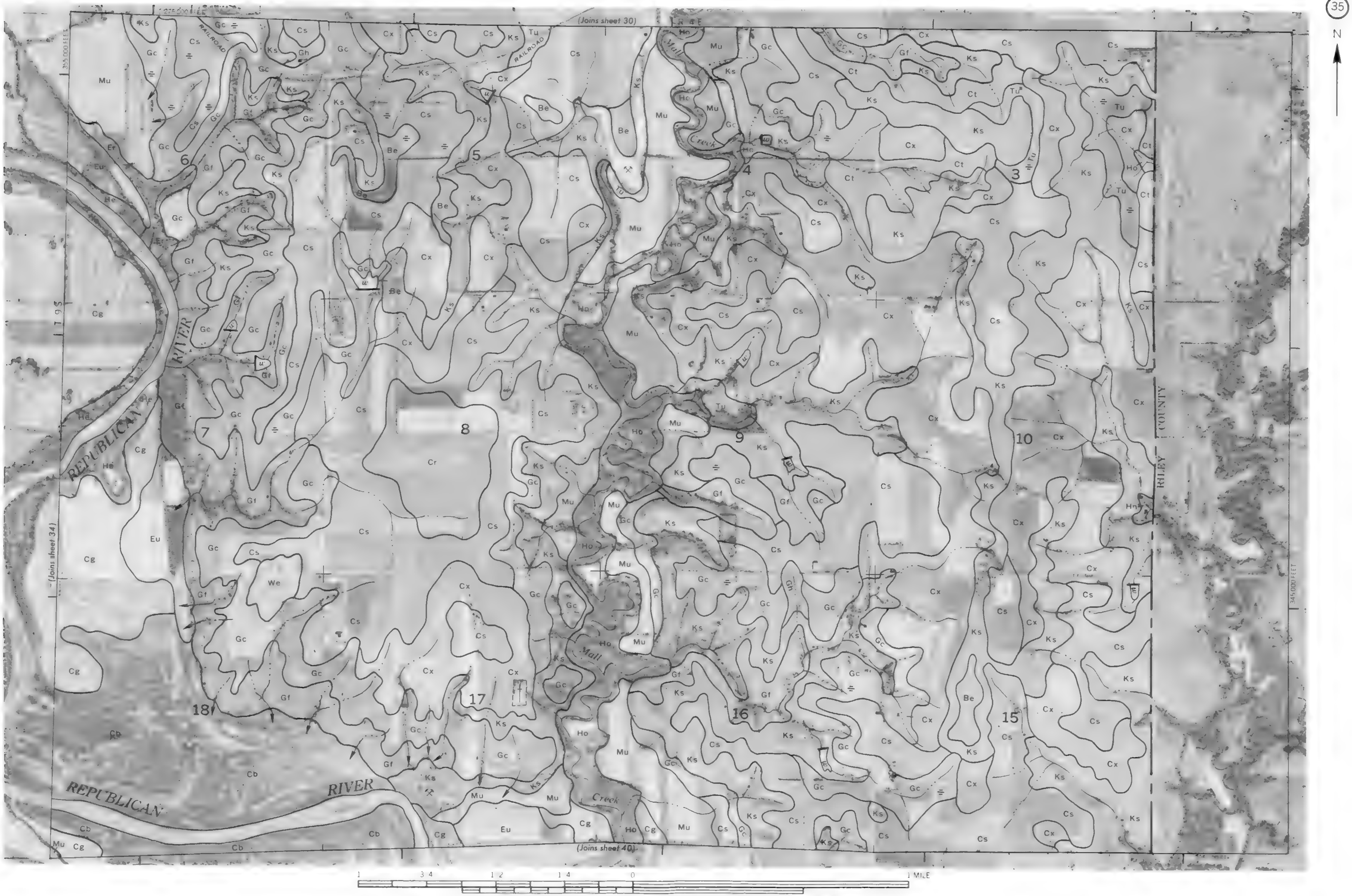

30
N
(Joins sheet 25)
R. 4 E.
(Joins sheet 29)
(Joins sheet 35)
RILEY COUNTY
T. 8 S.
19
20
21
22
27
28
29
30
31
32
33
34
West Branch
Mall Creek
Countryside Church
RAILROAD
water
1 MILE
1 KILOMETER

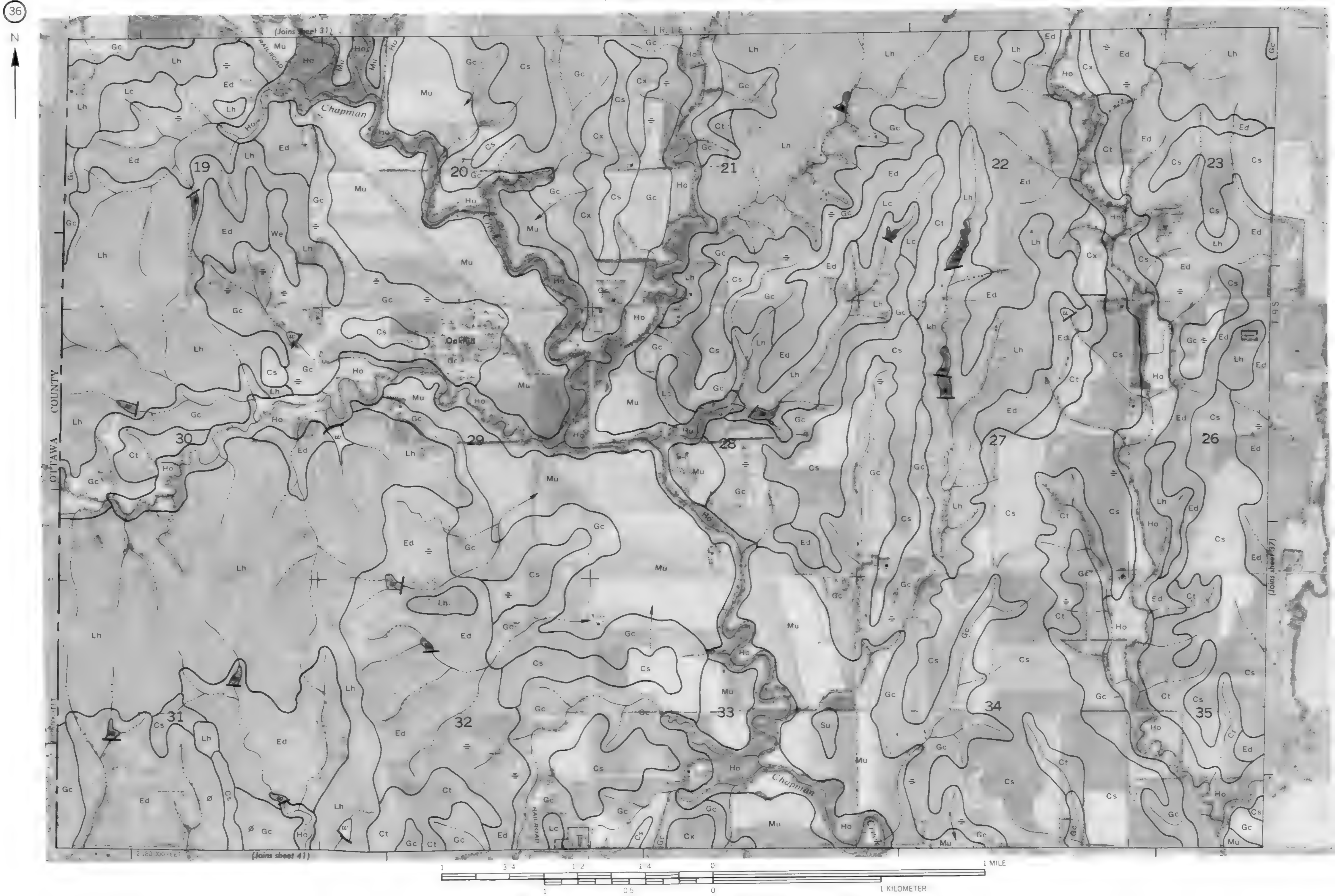

31
N
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 36)
OTTAWA COUNTY
Chapman
RAILROAD
water
1 MILE
1 KILOMETER
0
0.5
1


32
N
R 1 E
R 2 E
(Joins sheet 27)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 37)
T 9 S.
2 105 000 FEET
1 MILE
1 KILOMETER

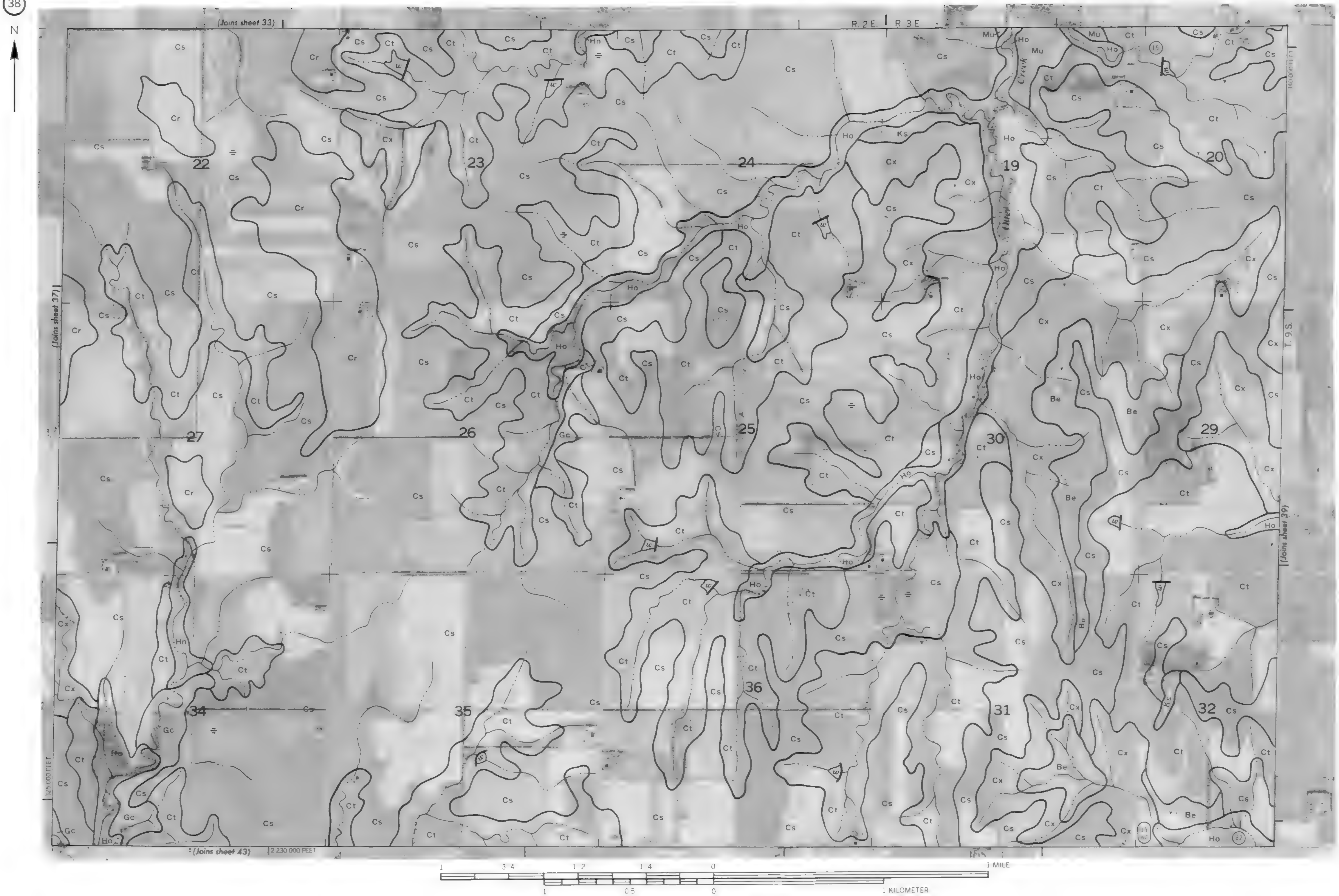

33
N
R 2 E. | R 3 E.
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 32)
(Joins sheet 38)
T 9 S.
Reeder Branch
water
Otter Creek
Ladysmith
Cs
Ct
Cx
Cr
Hn
Ho
Mu
Ks
Be
Lc
Gc
1 2 3 5 6 7 8 10 11 12 13 14 15 17 18
1 MILE
1 KILOMETER

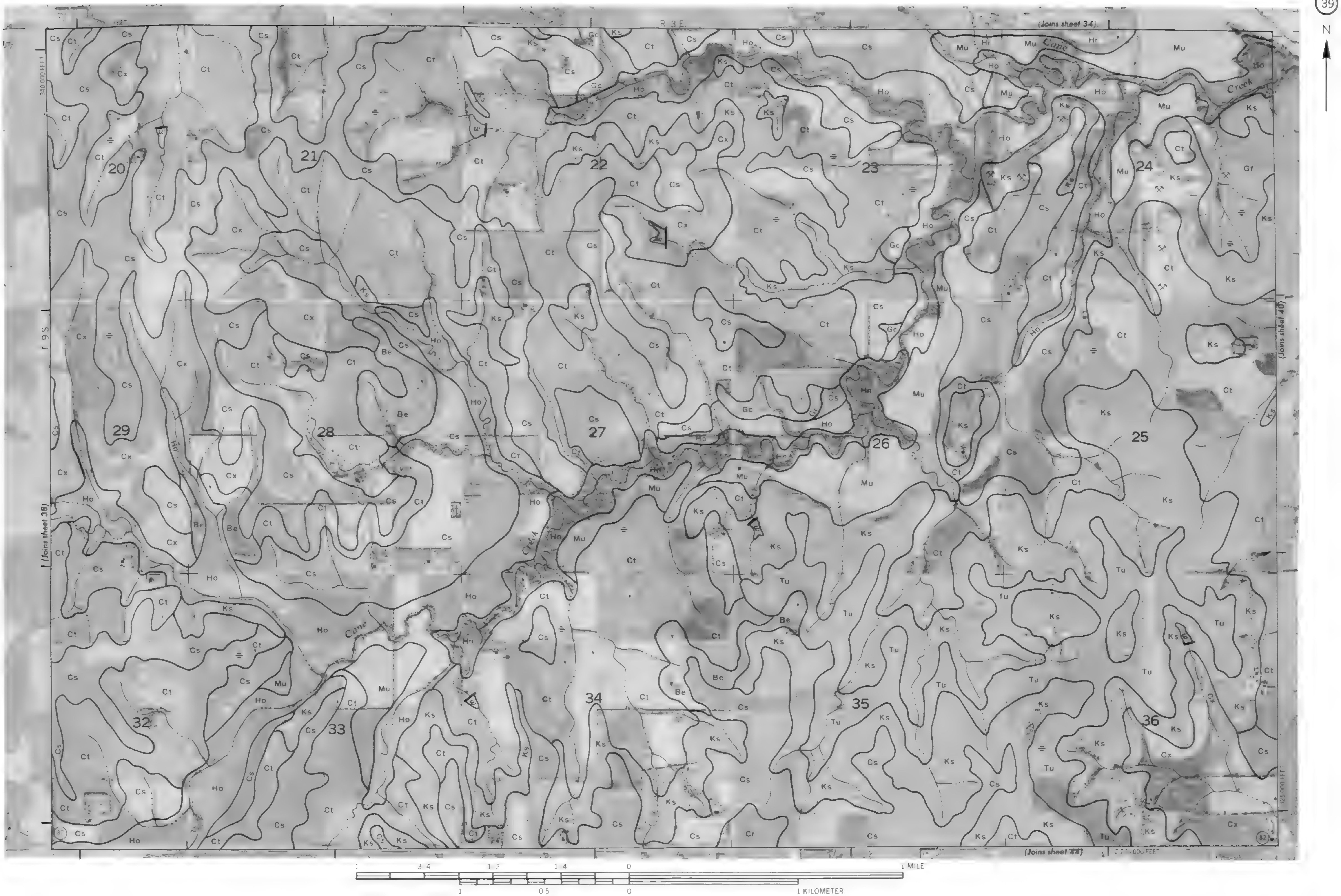

34
N
(Joins sheet 29)
R. 3 E.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 39)
Otter Creek
Creek
REPUBLICAN RIVER
REPUBLICAN RIVER
355 000 FEET
T. 9 S.
2 250 000 FEET
1 MILE
1 KILOMETER


35
N
(Joins sheet 30)
(Joins sheet 34)
(Joins sheet 40)
REPUBLICAN RIVER
RILEY COUNTY
RAILROAD
Mall Creek
1 MILE
1 KILOMETER

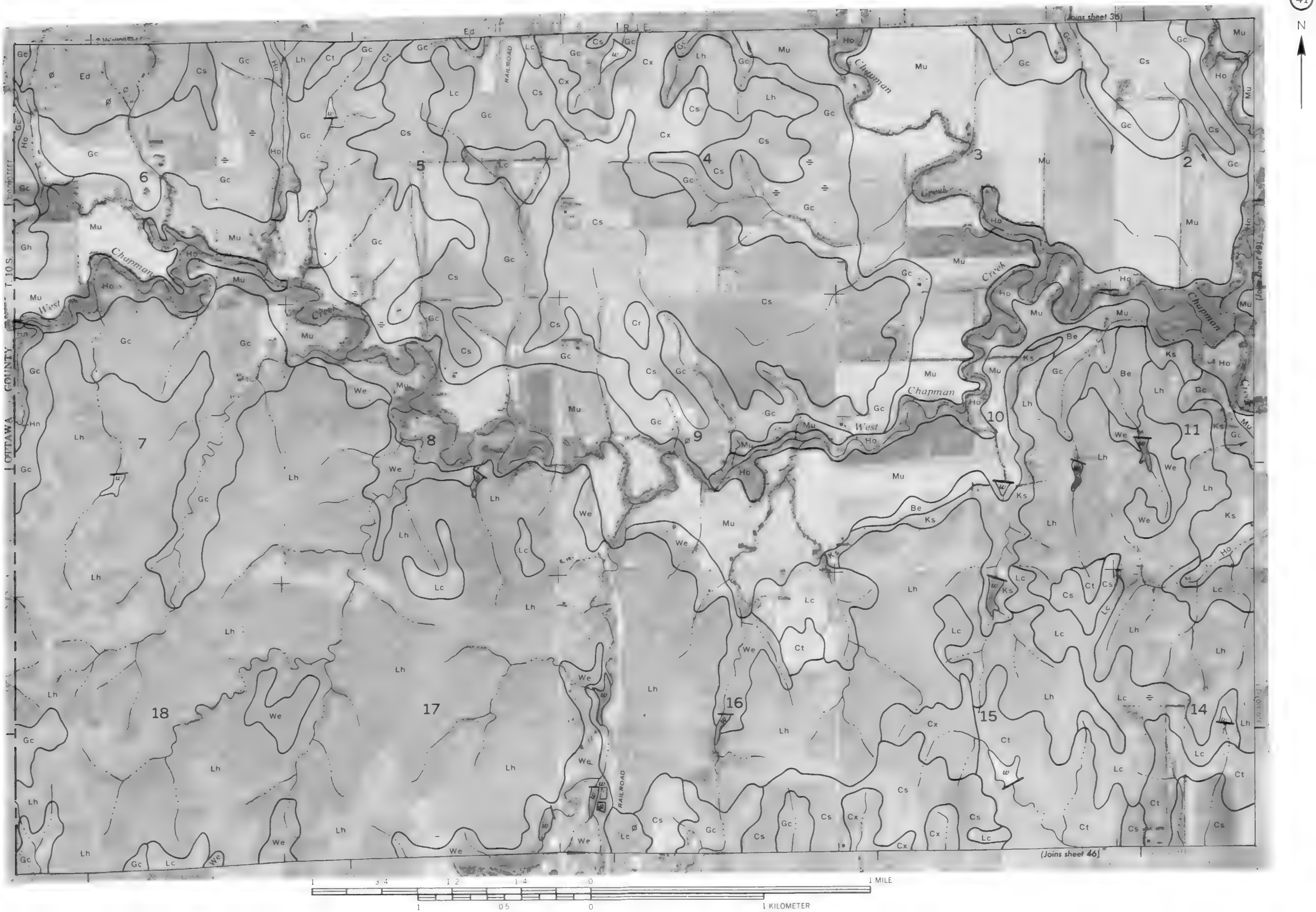

36
N
(Joins sheet 31)
R.1 E.
RAILROAD
Chapman
Creek
Oakhill
OTTAWA COUNTY
T.9 S.
(Joins sheet 37)
(Joins sheet 41)
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
1 MILE
1 KILOMETER


37
N
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 42)
(Joins sheet 36)
T 9 S
Bethany Church
1 MILE
1 KILOMETER


N
(Joins sheet 33)
R. 2 E. | R. 3 E.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 43)
T. 9 S.
340 000 FEET
325 000 FEET
2 230 000 FEET
Otter Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 MILE
1 KILOMETER
0
0.5
1


39
N
R 3 E
(Joins sheet 34)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 44)
T 9 S
340 000 FEET
Cane Creek
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 MILE
1 KILOMETER


40
N
(Joins sheet 35)
R. 4 E.
REPUBLICAN
RIVER
Cane Creek
Mall Creek
Timber Creek
MILFORD
RESERVOIR
(Joins sheet 39)
(Joins sheet 45)
RILEY COUNTY
19
20
21
22
27
28
29
30
31
34
1 MILE
1 KILOMETER


(Joins sheet 36)
(Joins sheet 42)
(Joins sheet 46)
R. 1 E.
T. 10 S.
OTTAWA COUNTY
RAILROAD
RAILROAD
Chapman
Creek
West
Chapman
Creek
West
Chapman
Creek
Chapman
N
1 MILE
1 KILOMETER


N
R.1E.
R.2E.
(Joins sheet 37)
(Joins sheet 47)
(Joins sheet 41)
(Joins sheet 43)
T.10 S.
Chapman Creek
Badger Creek
2 205 000 FEET
2 215 000 FEET
310 000 FEET
1 MILE
1 KILOMETER


43
N
(Joins sheet 38)
R. 2 E. | R. 3 E.
T. 10 S.
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 48)
Mizpah Church
2 245 000 FEET
110 000 FEET
1 MILE
1 KILOMETER
Cs
Ct
Cx
Gc
Ho
Ks
Mu
Be

44

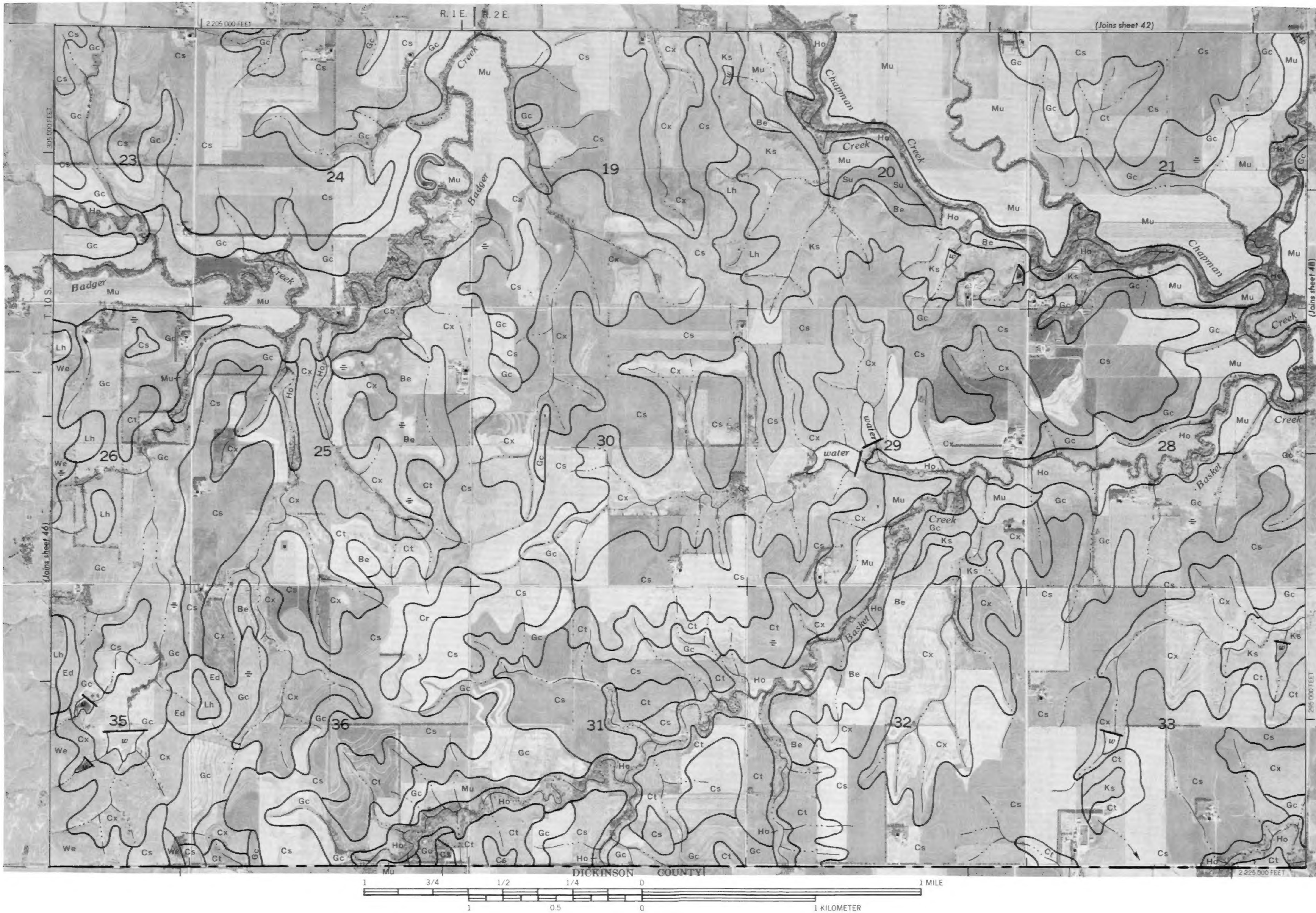
N


(Joins sheet 39)
R. 3 E.
(Joins sheet 43)
(Joins sheet 45)
T. 10 S.
(Joins sheet 49)
2 250 000 FEET
1 MILE
1 KILOMETER


N
(Joins sheet 40)
R. 4 E.
(Joins sheet 44)
(Joins sheet 50)
T. 10 S.
2 275 000 FEET
2 295 000 FEET
310 000 FEET
Wakefield
MILFORD
RESERVOIR
GEARY COUNTY
Quimby Creek
SEWAGE LAGOON
water
1 MILE
1 KILOMETER

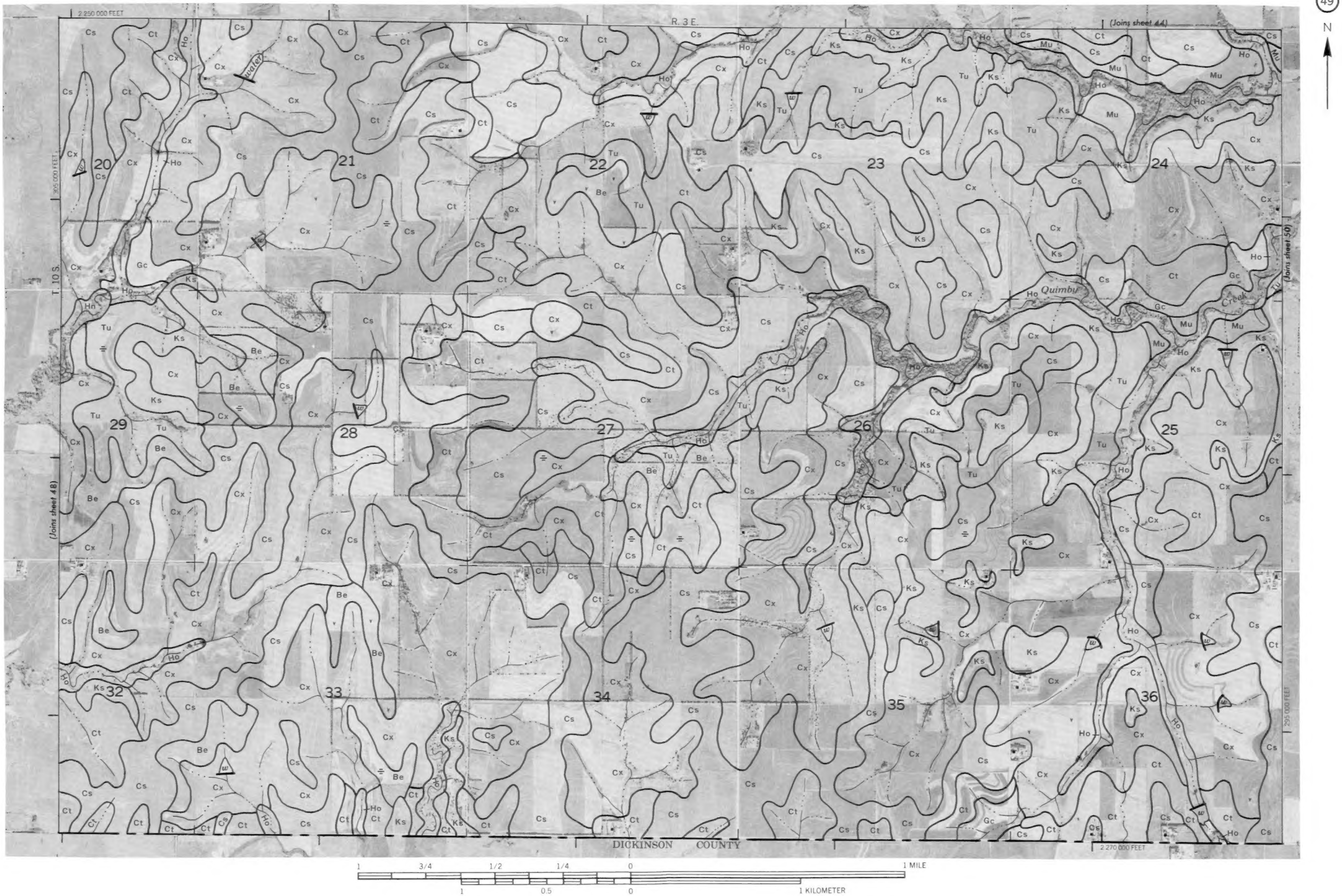

46
N
(Joins sheet 41)
R. 1 E.
RAILROAD
Longford
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Badger Creek
Badger Creek
T. 10 S.
(Joins sheet 47)
OTTAWA COUNTY
DICKINSON COUNTY
Water
Water
1 MILE
1 KILOMETER
Gc Lh Cs Lc We Ho Mu Ct Gh Cx Ed

47


R. 1 E.
R. 2 E.
2 205 000 FEET
(Joins sheet 42)
(Joins sheet 46)
(Joins sheet 48)
T. 10 S.
Badger Creek
Chapman Creek
Basket Creek
water
DICKINSON COUNTY
2 225 000 FEET
295 000 FEET
305 000 FEET
1 MILE
1 KILOMETER

CLAY COUNTY, KANSAS — SHEET NUMBER 48

CLAY COUNTY, KANSAS — SHEET NUMBER 49



CLAY COUNTY, KANSAS — SHEET NUMBER 50